The Role of the Danish National Patent Office in innovation

Christensen, Jesper Lindgaard; Rasmussen, M.

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The Role of the Danish National Patent Office in Innovation.

By

Associate Professor
Jesper L. Christensen

Research Assistant
Mia B. Rasmussen

Department of Business Studies
Aalborg University

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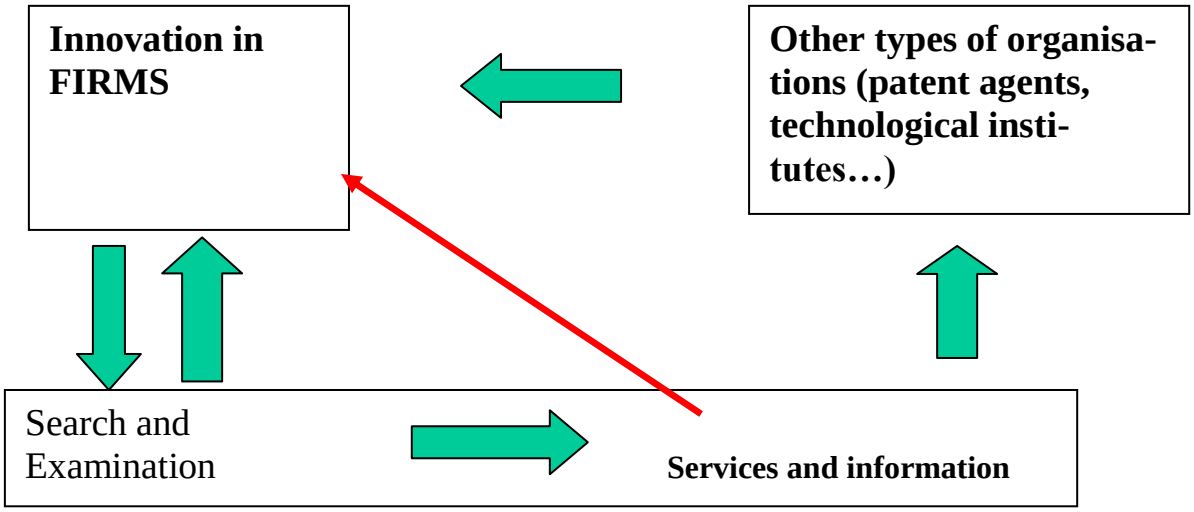
1. Introduction

Innovation studies have increasingly focused on the role of knowledge generation in the economy. Generally, the emphasis has been on the knowledge generated in the interaction between firms and various partners such as suppliers, customers, consultants, knowledge institutions, and universities. The latter type of institution has been said to be important producers of knowledge, as well as a key source for diffusion of knowledge in the economy. Innovation surveys asking firms about their sources of knowledge for innovation show that firms use a multiple of different knowledge inputs[1][2]. These surveys are important in understanding the patterns of knowledge flows. In addition to surveys, innovation researchers also use patent statistics to learn about the knowledge flows in the economy and the impact of innovation processes. In fact, patent statistics have been the most important innovation output indicator in the history of innovation studies.

This report highlights an aspect of patents often overlooked or scarcely researched. Rather than examine the content of the patent and the characteristics of the applicant firm, this study investigates the competence building and knowledge diffusion resulting from a) the processing of the patent application and b) the provided services related to patenting[3]. This analysis contends that the interaction between the applicant firms and the patent office, in this case the Danish Patent and Trademark Office (DKPTO), will add to the general competence of both parties. In turn, this may have positive long-term effects on the ability of the firms to innovate and to use the intellectual property rights (IPR)-system on the one hand, and on the other hand the competence of the patent office. The internal competencies resulting from processing applications are likely to spill over to other activities, thus enhancing other departments' abilities to provide services, not only to firms directly (the main focus in this study), but also indirectly through various types of intermediaries. This model of stimulating innovation is illustrated in figure 1.1.



[1] This is further discussed in section 3 of this report.
[2] Among the sources of innovation surveyed (e.g. in Community Innovation Surveys) is the information released from patent descriptions. One should also mention bibliometric indicators such as citation statistics as an important output indicator.
[3] In chapter 3 is explained in more detail what are these services.

The normal operation of national patent offices is rarely discussed; mainly they are seen as part of the regulatory framework together with standard-setting agencies. Reviews for improving the dynamics of a national patenting system disregard the technology diffusion potential of the institutions themselves.[4] Even if not mentioned directly, an overview of innovation indicators almost mentions the need for studies of this kind:

> However, areas where additional research is needed include the relationship between codified and tacit knowledge in firms and industries, the flows of know-how in national innovation systems and within multinational companies, the impact of patents on the diffusion of innovations, and the efficiency of national intellectual property systems. (Archibugi, D. & Pianta, M., 1996, p.48)

Most of the research issues mentioned above are either touched upon or dealt with more thoroughly in this study. This research problem has both an intra-organisational and an inter-organisational perspective. The intra-organisational aspect is the competence build-up within the patent office, where this report contends that competencies increase among patent examiners and this leads to positive spillover to other activities, especially services. The inter-organisational aspect has to do with the ability of the DKPTO to use competencies generated through the processing of patent applications in its future interactions with firms. Likewise firms' ability to invent and to use the IPR-system may improve as a result of the interaction, thus increasing the overall innovative activities in the economy.

While research has been done on a cursory level, this study attempts a deeper examination into these interactions. According to Edquist and Johnson (1997):

> It may be necessary to be more specific than we have been with regard to which kinds of specific institutions influence innovation and in what ways. Not much empirical knowledge exists on this. …. the character and strength of the interactions between organizations and institutions is an important research issue….Case studies of the relations between institutions and organisations and their role for innovation would be an appropriate approach for the time being.

From the explanation above it is hopefully clear that the research is not on the analyses of patents per se or on the economics of patenting. Rather, it is on the institutional role of the patent office in innovation.

The study proceeds in section two with a more thorough theoretical discussion on the rationale for the research question. The section addresses the issue of whether the theory on innovation and learning justify the relevance of the research? What do we know about the learning effects from the

[4] For example, even if the study done by the researchers of the STEP (Science, Technology, Economic Policy)-group in Norway on the Norwegian innovation system does include a short passage on the possible knowledge diffusion effect of the patent office (as one of the very few publications), then the patent office is nevertheless grouped under "public regulatory" (Smith et.al, 2000). Likewise, Edquist & Johnson (1997, p.59) and Johnson & Gregersen (1997) have grouped institutions of importance that are necessary for innovation into organisations for knowledge production, knowledge distribution, and knowledge regulation. Patent offices are discussed in both publications and both identified these offices as regulatory entities.

interaction between firms and institutions like patent offices? This section is more than an academic exercise. It provides valuable insight into the interaction between firms, institutions, and other key partners in the patenting process. These findings are an important prerequisite for the later extensive review of this issue. Section 4 looks at the patent office in Denmark in its institutional context[5]. This section discusses the complementary institutions in the innovation system and their place in the overall national innovation system. Even though the interaction between firms and the DKPTO is the primary focus of this study, the relationships of other types of organisations in the patenting process are also discussed in various sections of the paper. Section 4 provides a description of the DKPTO with an intra-organisational perspective, with a view of the way that knowledge is flowing between departments within the DKPTO. Additionally, the patent application process is discussed, and the activities of the national patent office. The purpose of this section is to show where learning and competence building may take place, while exploring the intra-organisational learning processes that may produce spillover effects of competencies from patent examiners to other departments of the DKPTO. Section 5 continues on this track, showing not only where learning between the DKPTO and firms may take place, but also what is learned in the interaction. This is done by way of four illustrative case studies attempting to show whether these learning effects are theoretical constructs or real world phenomena. The case studies were carefully selected and used as illustrations of potential positive outcomes. What was the real significance of these cases is the focus of section 6. The cases do not confirm that the effects put forward in this study are widespread in Danish firms. As a result, a survey was undertaken to determine if the services provided in relation to patenting contributed to a build-up of innovative capabilities in Danish firms. The concluding section 7 summarises the findings and points to perspectives based on the research findings.

The study was done in the period march 2001 until November 1st headed by Associate Professor Jesper Lindgaard Christensen and assisted by Research Assistant Mia B. Rasmussen, Department of Business Studies of Aalborg University. They undertook the research in collaboration with the Danish Patent and Trademark Office. The authors wish to thank their colleagues in the Department of Business Studies, Aalborg University for comments on the issues in this report. Also thanks to ESST-student Joseph Stewart, Texas for language editing. We are grateful to Patent manager Dan Nissen of Sauer Danfoss for critical assessment of an earlier draft of the questionnaire used in the survey. A special thanks to Ole Kirkelund and Steffen Rebien of the DKPTO for comments on preliminary findings and earlier drafts, as well as written notes on the content. Finally, we would like to thank all the people who helped us with information and data during case studies, survey and internally in the DKPTO.

[5] In innovation studies the concept ”institution” most often refer to informal rules, norms, routines, whereas patent offices and alike are referred to as ”organisations”. However, in the following the term “institution” is used for formal institutions/organisations.

2. Learning processes in the interaction between knowledge institutions and firms

2.1. Introduction

It is widely believed that knowledge is a critical asset in the present mode of production. The move from production based to a large extent on land use and machinery to a mode of production heavily dependent on human skills has even been compared to the transformation occurred during the industrial revolution[6]. Terms like "information society," "the knowledge-based economy" and even "the learning economy" are now part of the daily vocabulary of academics and policy-makerpolicy-makers alike. Modern economic theory now emphasise strongly that knowledge is the most important asset and learning the most important process in production[7]. A policy strategy for promoting economic development is consequently often said to be to increase the knowledge base of the economy and the speed of knowledge diffusion in the economy. One of the most prominent policy strategies in many countries is to stimulate the interplay between key actors in the innovation system.

In spite of the general agreement on the importance of knowledge and learning our understanding of the process of knowledge creation and diffusion remains limited. Likewise, the indicators used to measure knowledge are underdeveloped. This deficiency exists at least with respect to economics. The cross-disciplinary application of economics to what is generally known about knowledge and learning within. e.g. educational research is yet to be done.

With the case of DKPTO-firm interaction in mind, this section sets out to point to important advances in the theory of innovation[8] and knowledge creation and –diffusion relevant for the research

[6] Freeman and Perez (e.g. 1988) are among the early scholars arguing that especially the ICT-revolution represents a qualitative new paradigm in the production mode. Several more recent works have followed this line of argument, often with the U.S. development as case (see e.g. Thurow, 1997, who link this development to potential reforms of the IPR-system).

[7] Of course, production has to some degree always been knowledge-based and the concept is not new in economics. For example, Marshall stated that "knowledge is our most powerful engine of production" (Principles, 1920). However, the importance of knowledge has greatly increased and has regained interest in economic theory. The latter renewal of interest in knowledge in economic theory is both carried by a group of non-neo-classical economist and a revisionist wave among more traditional economists, exemplified by, e.g. Krugman and Romer.

[8] So far the concept of innovation has been taken for granted, but it is appropriate to define what is meant by "innovation". In the following examination we shall stay in-line with commonly accepted OECD definitions regarding innovation, the development and introduction on the market of new products, and those related to the development and application of new methods of production. In innovation studies it is rarely specified what is meant by "new." Or another question: to whom is it new and how new does it have to be compared to the previously used process or product, in order to be considered different from the old one? By "new" product or process is meant in this study that new products are significantly different from those previously produced by the firm with regard to material, design, technical specifications and areas of use. New processes are characterised by an impact on the possibilities of producing new products or existing products more rationally. "Innovation" is thus related to the firm and its previous mode and range of production,

in this project. It discusses in sequence the definition, production, transmission and transformation of knowledge. Emphasis is put on the intra-organisational aspects of knowledge. The macro perspectives, in terms of the national innovation system, are then briefly discussed. Also, briefly discussed are the implications of the theory developed for the applied research in subsequent chapters.

2.2 What is knowledge?

As already indicated in the introduction to this chapter, learning processes are important features of the innovation process be it learning-by-doing (Arrow, 1962), learning-by-using (Rosenberg, 1982), learning-by-interacting (Lundvall, 1985, 1988) or learning-by-learning (Stiglitz, 1987). These processes are important medias for the development of new combinations of knowledge and generation of new knowledge. Many observers claim that knowledge is a social phenomenon and therefore innovations are to a certain extent also characterized by some kind of direct or indirect interaction with other people/organisations and previously developed knowledge. We shall return later to this point.

Several taxonomies of knowledge have been developed. For example, according to Dosi (1988, p.224) knowledge is a precondition for solving an innovation problem, and it has at least three dimensions: It can be universal versus specific, articulated versus tacit, public versus private[9]. Even though these kinds of knowledge are relevant to innovation processes, knowledge in innovations is often specific, tacit and private. Therefore, information is not an ordinary commodity (with public appropriability), as Arrow (1962, 1973) points out. Knowledge may be very valuable to some, but at the same time useless to others[10][11].

The understanding of knowledge has developed rapidly in the past decades. In the traditional, craft-based learning the implicit learning through participating in or watching action is the most important knowledge. Development of skills was largely linked to a local praxis, often only written down in crude, general specifications. In studies of learning in the education system (Schön, 1987) knowledge was generally seen as instrumental, technical and rational. Moreover, knowledge was seen as fact-based and codified. In modern learning theories the concept of knowledge is now more diverse. Linking back to the work of Polyani (1957, 1962, 1966) the tacit aspects of knowledge has re-gained interest. Therefore, studies of learning processes increasingly focus upon the tacit knowledge generated by participating in practical problem-solving (Wackerhausen, 1992).

When discussing the concept of knowledge, Lundvall & Johnson (1994) mentions 4 kinds of knowledge: know-what, know-why, know-how, and know-who. Know-what is knowledge about facts that are concrete information that may be checked since this information is usually codified. Know-

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rather than a market perspective. This may at first glance seem odd given that the present study is on the role of Dkpto in innovation. Patents are clearly indicating something new to the market, not only the firm. However, the point maintained has not to do with the specific patent in question, but rather with a general increase in the long-run ability to innovate and diffuse innovative knowledge.

[9] As will be discussed in more detail later, knowledge can also be either individual or collective, and it may be embodied or disembodied.

[10] Zander (1991, p.109-126) provides a more thorough discussion of knowledge aspects of technology using Winthers' (1987) taxonomy.

[11] Arrow has described a dilemma concerning information and innovations. On the one hand it is important to give information about the project to raise funds, but on the other hand competition poses a limit on the information flows - the innovation must have a degree of secrecy.

why is knowledge on the driving forces behind, e.g. the development in nature. It therefore includes physical laws. Know-how is skills, the capability of an individual, organisation or team to apply useful knowledge and information to solve a problem. Know-who is the knowledge about who knows what and who knows what to do. With increasing complexity of society and increasing use of different knowledge bases in development activities, this kind of knowledge becomes still more important. If the "new economy" is denoting – among other things – the increased tendency to create networks among firms, and a highly developed division of labour, then it becomes immensely important to have know-who knowledge.

Tacit or implicit knowledge denotes knowledge that is stored either with firms or individuals as experiences, routines, and norms. Tacit knowledge is often context specific that is specifically related to the production structure in which it was created. It requires often an interaction between agents and is therefore facilitated by trust, cultural and geographical proximity, and a common understanding between the parties. This makes tacit knowledge difficult to imitate. Codified knowledge, on the other hand, is knowledge that may be written down in "manual form." It is thus organised and standardised in order to be understood by the receiver. The storing and transmitting of codified knowledge is not only easier, it is also less costly. In some cases, however, it is impossible to make some of the knowledge explicit and transferable. The two types of knowledge should, however, not be seen totally separated. An intelligent sorting and use of codified knowledge requires an element of tacit knowledge. In addition, what has been said to be an "information overload," that is, a steadily increasing amount of information, require an absorptive capacity in order to use information in an adequate manner. Within the past decade the storing and use of knowledge has become an important element (although not the only one) in a specific management discipline, known as knowledge management. The rapid expansion of this kind of discipline shows the importance of access to useful knowledge. However, the experience also shows that the codification process of knowledge in firms who intend to implement knowledge management has its limits and its costs. Similar experience has resulted from the development of expert systems (Foray & Lundvall, 1995).

2.3 Knowledge creation?

Although the know-how/know-who typology is helpful in understanding the nature of knowledge it may be a bit too static to show the knowledge creation process. This process is, of course, studied in education sciences but increasingly now also in economics in relation to intra-firm processes. Notably, Nonaka (1995, 1999) has developed a model, which shows how knowledge creation may be a process of interaction between individual and organisational knowledge embedded and developed in a social context.

Nonaka points to a number of preconditions for the fulfilment of the entire knowledge creating process. He mentions, that open and good dialog among the members of the organisation must be ensured and the employees should be allowed to wandering about and observe. Furthermore, Nonaka mentions trust and collaboration as key elements in ensuring optimal knowledge creating. The organisation can support the knowledge creating process by selection of the right visions, strategies, structure, system and management. Nonaka refers to these conditions as enabling conditions, which continuously enables the promotion of the knowledge creation process (Ruggles R. and Holtshouse D., Nonaka 1999: 71).

His model conceptualises the knowledge creating process, in order to explain organisational knowledge creation. The model is also referred to as the SECI[12] model and it is based on the assumption that human knowledge is created and expanded through social interactions between tacit and codified knowledge. Nonaka refers to this interaction as knowledge conversion (Ruggles R. and Holtshouse D., Nonaka 1999: 65).

The SECI model illustrates the knowledge creating process, where all of the four modes need to be realized as an integrated process. This is done in order to optimise the creation of knowledge where completion allows the organisation to reach optimal levels.

Socialisation
The first process of knowledge conversion, according to Nonaka, is socialization. As the figure shows this mode converts tacit knowledge to other forms and other carriers of tacit knowledge. One member of the organisation might share their tacit knowledge with other members of the organisation and new tacit knowledge is created. This actual conversion can take place when shared mental models are used and/or when technical skills are spread through shared experience. This type of knowledge is not exchanged through language, but through observation, imitation and practice (Ruggles R. and Holtshouse D., Nonaka 1999:66). An example of this type of learning would be an apprentice who works with his master and learn craftsmanship through observation, practice and imitation.

Externalisation
The externalisation process is the conversion of tacit knowledge into codified knowledge. It is a matter of expressing the tacit knowledge in a language by using techniques such as metaphors, analogies, concepts and models. One may see the upcoming of "story telling," which is used as an instrument in management consulting with regard to organisational change, as an example of how tacit knowledge may be translated to codified knowledge even if this translation into a management practice is difficult.

The externalisation process is very important for the entire knowledge creation, because it ensures the possibilities of efficient and immediate spread of knowledge to a large number of members of the organisation (Ruggles R. and Holtshouse D., Nonaka 1999:66). In other words, when tacit knowledge is codified the knowledge can easily be diffused throughout the organisation to a large number of employees and the *combination* mode become possible.

Combination
The process of combination involves transferring of codified knowledge through the organisation. The process involves combination and systemization of concepts through symbols such as language and figures (Ruggles R. and Holtshouse D., Nonaka 1999:66). It is a matter of communication and the media used for this purpose can be meetings, telephone conversation, documents or computerized communications. Also, combinations of two different data-sets may sometimes render new insights and constitute a new codified knowledge. This new knowledge can be considered qualitatively more valuable than the sum of the previously independent two data-sets.

[12] SECI is an abbreviation of the words S = socialization, E = externalisation, C = combination, I = internalisation.

Internalisation

The last process of the SECI model is the internalisation process, which is a matter of expressing codified knowledge as tacit knowledge. The new knowledge created through combination is internalised into tacit knowledge again shared among the members of the organisation. Consequently it becomes part of the tacit knowledge base in the form of shared mental models or technical know-how. The new knowledge becomes a shared understanding, which is deeply rooted and is no longer questioned; as well as new valuable knowledge assets are created (Ruggles R. and Holtshouse D., Nonaka 1999: 67). An example of the internalisation process would be when a new organisation gets a new and complex program designed for the company. Each member is trained in the program until they are confident with using the system. The members have now all gained a shared understanding of the program and from now on when they discuss the system they do not need to see examples or get long descriptions of the program. Instead it only takes a few sentences to describe a certain problem in the program.

The SECI model describes processes of self-transcendence in organisations, which facilitate knowledge creation. When done correctly, the individual takes himself through the socialisation and the externalisation modes, which helps teams to transcend their current knowledge. The combination process helps the teams to reach the organisational level and finally the internalisation mode enables the members of the organisation to transcend to a super-personal level and so the organisation improve the tacit knowledge base. Nonaka states, that it is important the knowledge is articulated, or else it cannot be easily leveraged by the organisation. Sharing and accumulation of tacit knowledge, or isolated combination or internalisation of codified knowledge are only parts of the entire process. Also, personalized tacit knowledge needs to be shared, conceptualised, systemized and disseminated throughout the organisation, and then internalised by individual members of the organisation (Ruggles R. and Holtshouse D., Nonaka 1999:68). Therefore, it is important that all the modes are realized, so the knowledge creating process is optimised and the process of self-transcendence is realized.

2.4 How is knowledge transmitted?

In discussing the transmission of knowledge it is important to bear in mind that a simple exchange of knowledge is hardly feasible, which would more likely with information. Knowledge, however, requires some processing of information. As people differ in their ability to process information and the situations where the data was acquired, they also differ in their levels of knowledge. It is, however, enormously difficult to specify precisely the intermediate steps between information and knowledge, and it is likewise difficult to specify the transfer of knowledge between people. This is the issue of a discipline of learning theories with contributors like Piaget, Schön and Kolb.

Because of the problems with specifying ex ante the situations and combinations of interaction of individuals that produce productive learning, the market is likely to be inadequate as selection mechanism. Even if business theories have developed sub-disciplines like “relationship management” such tools are not really adequate in the normative, ex ante generation or stimulation of productive learning environments and -partners. The development of situations beneficial for learning implies among other things trust and various kinds of proximity. The latter has several dimensions, spatial, cultural, and historical, as mentioned above. Similar to the situations beneficial for generating knowledge, the transmission of knowledge may have several dimensions: spatial-, over time, between people.

To some extent a one-time/first-time exchange of knowledge is different from a situation where the parties know each other. The transmission of information is easier when relationships have been established and ways of communication, which are understandable by both parties, have been worked out. Once established through a process of learning, one is unwilling to pay the cost of building up new relationships implying a new series of learning processes.

> "A communication system has some cost of initial investment which is irreversible. In particular, a communication channel is used to greatest capacity when it has an optimal code for transmitting messages. This "code" need not be interpreted literally; the term refers to all patterns of communication and interaction within an organization, patterns that make use of conventional signals and forms that have to be learned. Once learned, however, it is cheaper to reuse the same system than to learn a new one; there is a payoff on the initial learning investment but no way of liquidating it by sale to others." (Arrow, 1974, p.19)

A prerequisite for efficient information exchange is common channels and codes of information, effectively distributed and understood. The specific channels and codes will reflect the cultural, geographical and organisational differences between the parties. Established relationships will be kept when satisfactory exchange of information (through interactive learning processes) has developed together with an establishment of competence on both sides. The establishment and maintenance of relationships between users of business services like the process of producing the final patent application and producers of these services is facilitated by a social and cultural coherence. However, there may be difficulties in the ability to process information. Therefore the interaction must lead to ways of pooling the information in a manner suited to the receivers' organisational structure and ability to process informational signals.

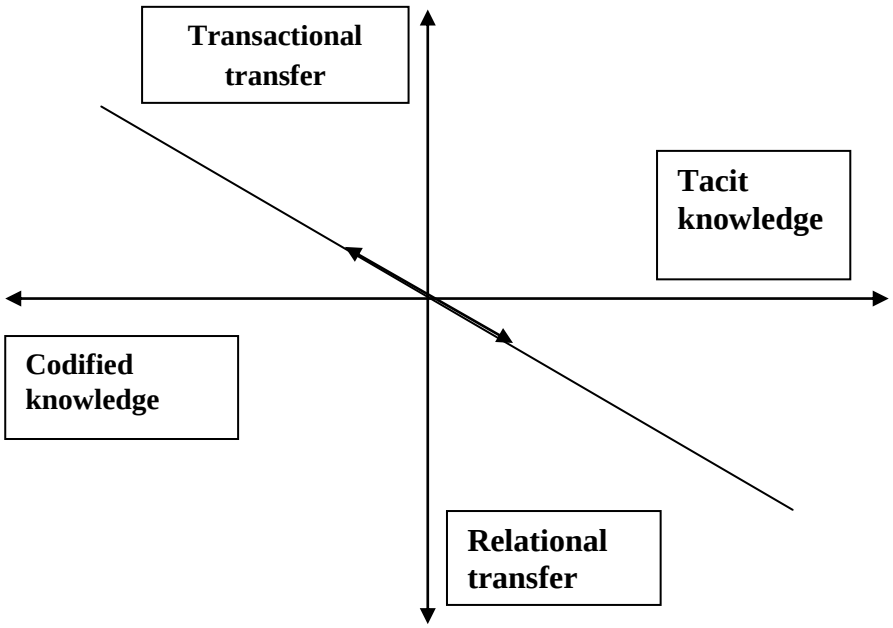
Many advantages resulting from such processes could be mentioned besides the alleviation of information problems related to the specific treatment of one patent application. The process is not only a development and accumulation of knowledge about a single patent application. As the one part becomes better at articulating requirements concerning the process, the other might be able to develop new procedures to meet these needs. Innovation theories have increasingly emphasised the interactive character of the innovation process (von Hippel, 1988, Lundvall, 1988) and the importance in inter-firm collaboration in innovation (Christensen et. al. 2001b).

There are, however, limits to the benefits of such "relational" transactions. The primary disadvantage of such relational transactions is probably its costs. In addition, it has been pointed to that these relationships or "strong ties" (Granovetter, 1973, Hansen, 1998), may produce inertia and lack of innovation (Arrow, 1974). In the words of Hansen (1998) the search efforts and benefits are constrained by the strong ties, whereas weak ties increases the possibilities of linking up to a larger array of different people and networks thus facilitating more opportunities and stimuli of ideas. Moreover, one may argue that whether close relationships are beneficial for the interaction or not, is highly depended upon the type of knowledge to be transferred. To explore this argument further we need to return to the distinction between tacit and codified knowledge. Moreover, we shall introduce the distinction between transactional and relational transfer of knowledge. As was mentioned above, tacit knowledge is rarely transferred by means of the market mechanism, but is rather transferred in a mutual, and often repetitive exchange of knowledge. This is necessary as tacit knowledge is often inherent in individual or collective routines, which are not necessarily written down or explicit even to the members of the collective. This type of knowledge is most efficiently transferred relationally.

On the contrary, standardised, codified information may be transferred by simple exchange without much interaction, sometimes through the market (Hansen, 1998). However, information and knowledge are, however, not purely either codified or tacit. As discussed in section 2.2, even the processing of codified knowledge may require the use of tacit knowledge, and agents may wish to codify procedures in order to learn what is our tacit knowledge. In other words, these two dimensions of knowledge may sometimes be interdependent.

Figure 2.1 illustrate this relationship between types of knowledge and the relevant transfer mechanism (Christensen et.al., 1999, p.20).

Figure 2.1: The relationship between type of knowledge and transfer mechanism



The figure shows, the more tacit the knowledge to be transferred, the more efficient are relational transfer mechanisms. That is, the more you go along the dotted line to the east in the figure, the more relevant is relational transfer. Interactive transfer is not necessary in the transfer of codified knowledge, on the other hand.

The specific mechanisms and media for exchange of knowledge may vary widely according to the situation and the partners exchanging the knowledge. In a recent study of the media for knowledge exchange during inter-firm collaboration on product development, Kristensen & Vinding (2001) explored three such medias, the exchange of employees, exchange of prototypes and exchange of knowledge by means of electronic media. They found that the frequencies in the use of different mechanisms are not that interesting in themselves, rather transfer methods seem to be complementary in a particular pattern. When employees are exchanged from the firm to a partner it correlates with exchange of prototypes, but not with electronic media. Conversely, exchange of employees from the partner to the firm correlate with complementary use of electronic media but not with exchange of prototypes. Referring to Nonaka & Takeuchi (1995, see also above-mentioned theory) the authors interpreted these results as a) the role of employees working in the partner firm when a prototype is exchanged is to capture and bring home knowledge on how the customer uses the prototype. This information could not be obtained electronically b) an employee from a partner working in the focal firm may have the role to complement codified information exchanged electronically with tacit knowledge.

The media and the way knowledge is transferred may also differ according to the absorptive capacity of the receptor. In the case of patents, there can be two kinds of the receptors. First, the patent examiner may need a broad and in some fields also a deep technological knowledge in order to undertake efficient screening of potential infringements of other patents. In this screening the examiner also needs knowledge on what are the most efficient search methods. Second, the other type can be other firms/entrepreneurs who are interested in the patent description. In order to use the knowledge from such descriptions the entrepreneur needs an absorptive capacity enabling him/her to not only understand the principles of the technology embodied in the patent. The entrepreneur also needs an element of creativity, as he must be able to apply this technology to other fields of use not covered by the patent or to see perspectives in the technology in terms of combining the technology with other existing technologies.

2.5 How is knowledge stored and transformed? – organizational learning and cross-departmental knowledge flows

It is obvious from the above discussion that tacit knowledge is not easily accessible for others. The tacit knowledge may therefore be the key to a competitive edge for some firms. Similarly, a patent may in some cases be essential for a firm. A paradox may arise here. On the one hand, protecting a new technology via a patent requires codification in order to specify in the application what is the technology. However, this process is exactly making the technology less excludable to others.

When knowledge is transformed into codified knowledge, e.g. by way of a patent description, it becomes possible – or at least easier for the market to access the value of such intangible assets. The transformation of tacit knowledge to codified knowledge is, however, by no means a simple

process, and is often not only difficult and costly but also only possible up to a limit. It involves for the transmitter to be conscious about the implicit habits, norms, routines rooted in the problem solving practises of the individual or team. In a next step it also involves describing that knowledge in a language, which is understandable to the receptor. The external receptor thus puts a constraint on the way the transmitter is to explain the tacit knowledge in a codified form. This constraint may be common terms of expression and ways of standardising certain explanations.[13]

In order to use the market as a means of transfer the knowledge traded must be transformed into something more comparable to an ordinary commodity. The value of a physical product may be stored and assessed if traded on a market. Supply and demand will then determine the price of that asset. Intangible assets may be difficult to value accurately on a market. In standard economic theory "the invisible hand" is only working because supply and demand is well defined and because the price mechanism signal changes in the preferences and production costs. The bulk of the theories using the market mechanism are developed with the trade of a physical product in mind. Trading knowledge on a market implies problems that go beyond those of transforming tacit knowledge to codified knowledge – which is one effort to specify the supply side. The specification is, however, often very situation specific. Consider the consultancy market. In very many cases the purchaser of consultancy services are not fully aware of what they need, this is specified in an interaction with the seller. On the other hand, the seller is not able to describe in specific terms what is offered, as this will vary according to the task. The seller may even not be willing to specify his/her knowledge in advance. If he described in detail the knowledge to be sold the purchaser will already have that knowledge and will then be unwilling to pay for it or it may affect the price negatively. On the other hand the seller is forced to reveal at least some of his knowledge to make the buyers interested at all (Arrow, 1962).

In addition, it is difficult to appropriate in a market the full benefits of knowledge. It has been pointed to in the literature on knowledge (e.g., Arrow) that knowledge is fluent and hard to control. Due to the special character of knowledge, the seller of knowledge (not broken down or lost in use or transfer – see section 2.2) is not losing the access to that knowledge and may sell it to other, competing firms. This will have an adverse impact on the market price of the knowledge. However, the seller may be unable to prevent the buyer from re-selling the knowledge, which may invalidate the incentives to produce that knowledge in the first place. Moreover, the "product" is produced in the very deliverance of the product. As a consequence of these difficulties in making the market for knowledge work, institutions are developed of which patents is probably one of the best known. Others include codes of conduct, which are often established upon the initiative of the market players themselves, rather than public authorities. In addition, the access to the market is itself to a large extent relational. The purchase of knowledge is often based on recommendations, rumours, and repetitive interactions.

In most real cases as well as in most academic studies of innovation it is clear that learning processes are developed or studied in relation to an activity, this was initiated with a very different purpose

[13] In Denmark the Ministry of Industry recently published common guidelines for knowledge accounts in firms, which are seen as important to stimulate and help firms in producing these accounts. Such guidelines involve a paradox as they are at the same time meant to standardise information according to certain rules. At the same time this may exactly prevent some firms from expressing precisely what are the intangible assets in the firm, as the standardised way of reporting may be seen as inadequate or limiting the precise expression of the intangible assets.

than generating learning effects. Education is the obvious example of the opposite view, and most theories on learning processes are developed within the education studies.

In recent years it has become common practise to organise work in a manner conducive for learning effects. This has been explicitly referred to in many books, articles and the business press as "the learning organisation". By gearing the organisation to improve the accumulation of knowledge from daily activities, the learning effects are likely to increase. This is basically what Stiglitz (1987) defines as "learning-to-learn," Pedler et. al. (1989) define learning organisations as "an organisation that facilitates the learning of all its members and continually transforms itself," Moreover, Pedler believes such an entity:

- "Has a climate in which individual members are encouraged to learn and to develop their full potential.
- Extends this learning culture to include customers, suppliers and other significant stakeholders.
- Makes human resource development strategy central to business policy.
- Continually undergoes a process of organizational transformation.

Indeed, by way of evaluations, the members of the organisation in question are also encouraged to reflect on the learning processes themselves. Within learning theories this has been called "double-loop learning" (Argyris, 1984, see later for further explanation). This is a difficult task that requires the agents to accurately identify what is learned and when does it occur, and in what ways. In case the knowledge accumulated could be characterised as tacit knowledge it becomes even more difficult to assess such learning processes effectively. This argument relates strongly to practically all evaluations as well as the issue for this current study: in virtually all evaluations the by-product, unintended learning effects are rarely valued often because there are no good measurements of them. The hypothesis developed in chapter 1 on the possible knowledge generating/diffusion effects of daily activities of the DKPTO is similarly difficult to test as the effects are likely to be more or less hidden and implicit, even to the receptors. For example, the patent examiners may unintended transfer knowledge to other parts of the organisation, not on the content of specific patents, but perhaps knowledge on general technological development. Likewise, they may be able to identify accurately what are the problems in the applications received. Where are the deficiencies in the ability of customers to put together an application? This knowledge may be both transferred deliberately, but also informally through daily interaction, transferred to the sales and marketing department, who may then try to educate customers on these points.

We shall elaborate this last point on intra-organizational learning and look into what is known on organizational learning. Applied to the DKPTO case, it is a matter of specifying the arrow in Figure 1 linking patent examiners and the Sales and Services department. However, this is not done empirically in this chapter. Here we focus upon theoretical considerations on this issue, whereas we pick up on the issue again in chapter 4, this time empirically. We proceed by briefly reviewing theoretical developments of organisational learning. This helps us to focus this broad issue on the parts of the theory most relevant for our empirical research question. We subsequently discuss instrumental aspects of intra-organisational learning and knowledge flows, that is, what could/is be done to stimulate such learning processes.

Organisational learning has been studied by a multiple of different disciplines as well as over a long span of years. The disciplines occupied with organisational learning encompass organisation theory, economics and psychology. The lengthy history of research into organisational learning goes back to Weber, or even before. Organisational learning has been studied by, e.g. industrial economists as

how learning affects industrial structures and productivity, and it has been a major part of theories of the firm (Cyert & March, 1963, Richardson, 1972, Nelson & Winther, 1982) as well as in recent theories on dynamic capabilities (Teece et. al., 1990, 1997). In recent years the amount of literature dealing with organisational learning has grown immensely. This growth may have been caused by several developments outside the pure academic disciplines dealing with learning. One important such development is the speedy change in the environment of the firm. In particular this is seen in terms of make rapid changes in products and processes, shortened product life-cycles and the integration of manufacturing and services, the latter implying that firms need to learn to do many different things. Together this has increased general uncertainty, and this complexity and uncertainty forces firms to increase their ability to rapid adjustments. Organisational learning is key in such a strategy to be responsive to change. The real world developments have influenced not only the area of consultancy but also academics, for example the strategic management literature. It should, however, be made clear that much of the literature, for example the management and innovation literature, does not see the increased interest in organisational learning only as a response to external stimuli (as does much of the organisation theory). Rather, it is seen as an important strategy to improve and retain competitiveness and innovative capabilities.

There are several prerequisites for making the intra-organisational learning processes productive. One is the absorptive capacity of the firm, which is said to be the ability of a firm to incorporate and learn from outside. Cohen and Levinthal (1989) see R&D as improving not only the innovations directly linked to the R&D expenditures, it also enhances the firms' general ability to assimilate and identify knowledge. This has been a major contribution to the current popular discussion on capabilities of the firm. Whereas the discussion in the literature mainly has been on the capabilities of the firm as a whole and on the absorptive capacity of the firm vis-à-vis the environment, we argue here that indeed such absorptive capacity is equally important when seen in an intra-organisational context. That is, among departments, or whatever organisational units the firm is operating with (we shall return to this issue below), there is bound to be a tendency to exploit knowledge generated and diffused from other parts of the organisation. Common verbal- and written codes of communication is a simple necessity. Additionally, intra-organisational learning may be spurred by procedural skills enabling members of the department/group to apply and use knowledge in different settings than where it is generated. Among several contributors to learning theories, it has been argued strongly that productive learning should basically be seen as situated learning, that is learning should be viewed as contextual and only useful if used in action and in a setting where the learning has been produced. We would argue that it is indeed a challenge for organisations to transform and diffuse knowledge produced within one unit to other units in a productive manner, but it is often an important part of organisational learning.

The other prerequisite for intra-organisational learning we would emphasize is co-ordination. The reason for pointing to co-ordination as a major issue is linked to the distinction between individual and collective learning. Even if organisational learning may go through individuals, the knowledge of an organisation is more than the sum of the knowledge of its individuals. Above individual learning the organisation may have shared norms and values, which preserve certain behaviours and routines. The establishment of routines, involving rules, procedures, conventions, cultures and strategies, make up the memory of the organisation. Nelson & Winther (1982) particularly emphasised the routines of the firm, which in their evolutionary theory is analogue to the "genes" of the firm. According to Nelson & Winter routines within the firm is based upon a) the sum of capabilities of the members of the organisation b) the use of these capabilities in concrete action by what is denoted "remembering by doing," and c) the co-ordination of (a) and (b) through transmission of mes-

sages (Foray & Steinmuller, 2001). The latter transmission of messages may be more or less systematic and co-ordinated by means of an overall plan. It is, however, at least as important that individual behaviour is guided by motivation and recognition of corporate culture and behaviour, says Nelson & Winther. A system of co-ordinated knowledge flows and routines must therefore be accompanied by an incentive system and a social system. The motivational dimension of the use of routines has since Nelson & Winther to date been largely neglected, with a few exceptions, but recently it has received increased attention (Cohendet & Llerena, 2001, p.7).

The build up of routines is largely a gradual learning process. This learning is based upon which solutions the organisation successfully used for problem solving in the past. Identification of a problem and strategy for its solution consequently involves remembering and retrieving solutions that previously were adequate for a problem resembling the one in question. A complementary aspect of this process is to remember solutions, which in the past failed to solve the problem. In other words, it is an important part of learning to forget unproductive routines and be able to rule out solutions likely to fail. In this way routines are important in the economising of information processing. The reason why the human brain does have a chance in a game of chess against the superior processing capacity of computers is that humans do not need to calculate all possible moves. Rather the position is setting a specific agenda enabling the human to concentrate on a few possible moves. Likewise the human in practise builds on existing knowledge (e.g., opening theory, previous games with positions resembling the present one) as well as a tacit sense of what is improving the position. Naturally it varies widely with the situation what should be left out and what deserves focussing. Therefore, routines are indeed context-dependent. Likewise, the relevant sum of capabilities is dependent upon the sum of knowledge of the members of the organisation, but it varies what is relevant according to the situation, which points to the necessity of interaction between members of the organisation. Only in this way is individual knowledge of the members activated, as well as the shared meanings and languages developed in the organisation.

The discussion above means that firms may have unique ways of learning and knowledge accumulation, which results is called “firm-specific capabilities (Teece et al., 1990), “core competencies” (Prahalad and Hamal, 1990), and “firm specific competencies” (Pavitt, 1991).

This is a static view of competencies. The dynamic stimulation of these learning processes becomes an equally important issue as soon as the importance of learning is recognised. The way firms learn in general have been described by Argyris and Schon (1978), who developed a three-level typology of learning. They contend that learning processes may be seen as single-loop, double-loop and deutero-learning. In their view single-loop learning is the identification and correction of errors without influencing the present objectives and strategies of the firm. Double-loop learning is when this correction makes the organisation modify its objectives and ways of doing things. A third level is deutero-learning which involves reflections of previous learning processes and adjustments and organisation in accordance with what is perceived as most efficiently stimulating single- and double-loop learning. This is a way of building strategies for learning by evaluating previous learning processes and what had an impact on these processes.

The modes of learning may indeed be even more firm-specific than the core competences of the firm. In other words, “learning organisations” may have very different modes of learning. This is linked to the need for co-ordination of knowledge. It is likely that even if all individuals of two organisations were learning the same in the same rate, the distinct ways that information and knowledge flows in the organisations may produce very different organisational learning. Therefore

co-ordination and management of mechanisms for learning within the firm is essential to the intra-organisational learning processes. This is even more so as in reality different groups within an organisation often has its own knowledge base and abilities to learn, and even, in some cases, its own culture. In spite of this, there is relatively little research on the diffusion of knowledge between departments or groups within the organisation. In the bulk of the literature the firm is seen as a homogeneous entity in which learning processes are taking place more or less as in an individual and without internal barriers and conflicts.

Basically co-ordination and stimulation of intra-organisational knowledge flows may be pursued differently according to what kind of knowledge is diffused. Using the distinction above between tacit and codified knowledge, we would argue that codified knowledge to a large extent may be diffused throughout the organisation by way of information systems, databases etc., whereas flows of tacit knowledge may be stimulated by means of organisation. Even if this is a rough division we are mostly interested in the latter case, and shall go a step further in discussing this approach.

It follows from the discussion of routines and organisational learning being context dependent that the nexus of the learning processes is important. We consider here the intra-organisational aspects of this, disregarding the inter-organisational aspects. However, there are large overlaps between the principles behind these two views.

In many discussions, the creation of routines and learning has to do with the relation between the individual and the organisation as such. However, we would argue that to a large extent the routines, capabilities as well as the shared languages and norms are created at an intermediate level of the organisation. This level is, of course, differs according to the size and structure of the organisation. However, we would contend that in many organisations it is possible to identify the different types of groups described below.

One of the best-known such groups is *functional groups*. These are characterised by homogeneous agents with roughly the same disciplinary training and specialisation. Traditional departments in an organisation such as sales, R&D, accounting etc. exemplify what may be understood as functional groups. Even in matrix-structured organisations functional groups may persist. In functional groups the learning mode is said to be learning by doing, unintended, and based on knowledge, which is based on disciplines. Likewise the recruitment is based on mastering of disciplines (Cohendet & Llerena, 2001, p.11). They ensure a specific function and are hold together by their task.

Another type of group is *community of practice*, which is usually associated with Lave and Wenger (1991) and Wenger (1998)[14]. In communities of practice, members are regularly communicating on their activities thus developing individual competencies with respect to the task undertaken. The communities are therefore dependent on the sum of individual capabilities, but there is a continuous interaction between members on the experience and common activities and objectives. This stimulates the community as a social entity. The knowledge produced is very specific to the objectives, norms and structure of the community and therefore interaction to the outside of the community is limited.

[14] In the Lave and Wenger book from 1991 ("Situated Learning") the focus was primarily on the social conditions for learning, whereas in the Wenger 1998 work ("Communities of Practice") a more holistic theory on the social dimensions of learning is developed.

A third type of group is *epistemic communities*. According to Cowan et al. (1998) such communities are defined as "*agents working in a commonly acknowledged subset of knowledge issues and who at the very least accept a commonly understood procedural authority as essential to the success of their knowledge activities*". The members of the group thus share objectives of knowledge creation and a common framework for the shared understanding and norms of the group. As opposed to communities of practice these groups are explicitly oriented towards knowledge creation and are accepting the procedural authority to reach agreed upon objectives. Deliberate search processes are primary learning mechanisms, and the knowledge is circulated among members of the group. As the members are often heterogeneous (as opposed to functional groups) it is a precondition for the group to function properly to develop a common language.

Intra-organisational learning has traditionally been stimulated by measures such as job rotation, team training across departments, integration of functions etc. Recently different instruments have been defined as knowledge management although the actual knowledge management function may range from establishing Intranet based common knowledge bases to improving consciousness of corporate culture[15]. In general, it may be said that codified knowledge is best "managed" by way of (IT-) systems, whereas intra-organisational stimulation of tacit knowledge may be done by way of organisation; initiatives related to work practices and –organisation.

Difficulties arise when an organisation is dependent upon the coordination of activities of different groups, be it two different e.g.functional groups or two different types of groups. In that case the codes of communication and intra-group objectives are not necessarily compatible. In the case of the DKPTO the patent examiners is one group and Sales & Marketing another. The activities of patent examiners are clearly guided by its' own (externally given) objectives. Likewise, the activities of the Sales & Marketing are determined by their main objective of selling various types of services and encouraging firms to apply for patents. If the efficiency of knowledge diffusion activities of Sales & Marketing is dependent upon diffusion of knowledge from patent examiners (as argued in chapter 1), it requires that extensive interdepartmental interaction (e.g. a community) is established with the objective of ensuring knowledge transfer. Two functionally separated departments (as is largely the case in the DKPTO) could, however, also handle the sale and production of services. As mentioned, this is likely to require mechanisms of knowledge transfer, and with limited interaction between departments, this transfer is unlikely to take place. Alternatively, the Sales & Marketing department would need competencies from elsewhere.

2.6 The national innovation system as a framework for learning processes

Innovation policies have largely focused upon the diffusion of knowledge (Christensen, 2001a). Theories within the "innovation systems approach" have likewise emphasized the diffusion aspects. Some even argue that what has been denoted the "new economy" is a steep increase in what may be termed knowledge externalities. Such externalities are non-pecuniary in the sense that knowledge produced by one agent – or a set of agents – may benefit other agents without financial compensation (Foray, 2000, p.2). The externalities contribute to the build up of the general knowledge base of the society, which is, in turn, beneficial for future innovators. In relation to the DKPTO-case in this study, the knowledge spillovers from treating an application can be said to be two-fold. As the in-

[15] A dilemma may be that what makes an organisation coherent is exactly what is not necessary to express. It may therefore be a challenge to reproduce to other members of the organisation.

teraction between the parties produce useful knowledge both within the firm and within the DKPTO as well, the spillover effect may occur. However, one prerequisite for this to happen is that the knowledge produced is not sunk, that is, if the knowledge has a very specific character, and is not useable in other connections, then the knowledge spillover is likely to be close to nil[16]. Later we shall therefore explore this important question in more detail.

The interaction between different types of agents is much emphasized in the innovation system approach and in evolutionary theories on technological change. This interaction is likely to expand the knowledge frontiers of society as a whole, and to enhance the knowledge base of the firms involved in such interaction. Thus, the learning effects of such vertical relationships are likely to differ from horizontal relationships. This is not to say that vertical relationships are more beneficial than horizontal interaction, it is just to emphasise that such knowledge flows are qualitatively different. Therefore, they may be valuable from a social point of view as the society is interested in knowledge diffusion. In the following we shall pursue this macro perspective further.

Both at a macro and at a micro-level, knowledge may be seen as cumulative. The individual learns based on past experience and forget what is assessed as irrelevant information[17]. Likewise, both research and technological development in general is guided by the accumulation of knowledge in society. The latter has been dealt with extensively in the literature on innovation although it has been phrased differently with different authors and modified in several varieties[18].

The discussions above have primarily referred to a non-specific context. However, the innovation process and learning processes are not only governed by inherent characteristics. They take place within external boundaries, which are of some importance to the processes. One important boundary is the nation-state[19]. In the past 15 years there has been an increasing recognition of this fact, reflected in the amount of studies focused on and using the concept of "national systems of innovation"[20] and in the use of the concept by policy-makers.

In spite of generally increased internationalization there are arguments why national borders are still a co-determinant for the scope of the innovation process. 1 it is plausible that complex technologies with many, specific inputs such as tacit knowledge and advanced demand patterns, require a higher degree of proximity between users and producers, thereby alleviating problems with communication costs through common cultures, language and geographical proximity. Likewise, it should be expected that

[16] In practise, however, this is likely to be a special case. Even very special cases are most often generating some kind of knowledge or experience, which may be used elsewhere.

[17] This is, of course, not a new insight in our knowledge on knowledge production. Thus, Foray (1997, p.71) cite Francis Bacon, who in the 18th century argued for the cumulativeness of individual knowledge: "each individual takes over from predecessors an accumulated store of knowledge, adds to it and passes the augmented store on to successors who are expected to make their contributions in turn". Similarly, a famous passage from Marshall illustrates the cumulativeness: "If I can see wide it is because I stand on the shoulders of giants".

[18] Famous contributions include those of Dosi (1982), Sahal (1985), Arthur (1988), Perez (1983).

[19] Lundvall (1992, p.2) points out that the concept of nation state has two dimensions: a national-cultural and a etatist-political. An ideal, abstract, and somewhat unrealistic state, is characterized by both dimensions.

[20] Actually the first study with this focus dates back a long time in history (List, 1841). Some of the first studies in more recent years include Freeman (1987), Nelson (1988, 1992), Porter (1990), Lundvall (1988) and Lundvall(ed.) (1992). McKelvey (1991) compares some of these studies, and Lundvall & Christensen (2000) review the development of the innovation system concept and argue that a broader concept is needed encompassing the increased role of human capital in production.

proximity is more important in early stages of the development of a technology, while more distant relationships are sufficient in downstream, or even standardized, technologies (Lundvall, 1988). Distance is, however, not a complete argument for the nation-state as a boundary for the innovation process. The argument could equally well be applied to regions or local areas. On the other hand, even if counter-examples are easily found, the general picture is that language, culture and business norms to a large extent coincide with national borders.

2) legislation, standards and other regulations, are primarily national, and this is important to firms when choosing their innovation strategy. Even if liberalized, public procurement is often directed towards domestic products, and the overall government technology-, industrial-, and economic policy has a national focus, this also affects the innovation process.

3) the paths for exploration are defined through a historical process of interplay between demand patterns and the domestic production structure. The existing range and specialization of products produced in a country largely reflects this process, and it is not as easy to switch path as it is to import goods.

4) some of the knowledge that is valuable to innovations is produced in public laboratories, universities and other parts of the education system, which is primarily national. This knowledge infrastructure has become much more important in the past decade or more (Smith, 1997). Telecommunication systems, libraries, databases, education and vocational training system. are important elements in this infrastructure.

5) the institutional infrastructure in other areas is largely national in character. Among important institutional factors are the financial institutions, the technological service institutions, appropriability system as well as more traditional infrastructures.

and 6) if certain efforts have been done to harmonise labour markets and increase mobility of labour across borders, then the rules and workings of labour markets remain largely national. As labour markets indeed have a large impact on innovative activity in the economy (Lundvall, 2001), the limited mobility across borders of the labour force is another argument for the effect of the nation-state on innovations.

Although these are arguments why the nation-state is still important as a framework for innovation and learning, it is important to stress that this is, of course, an open and non-exclusive one. It is open in the sense that it may easily be the case that a firm is bounded by the national innovation system. It is also part of another type of system, e.g. a sectoral system of innovation (Carlson & Stankiewich, 1991, Breschi & Malerba, 1997). It may also be that a firm really does not need the nation-state in some cases, but is highly dependent on it in other areas of activity.

It should also be noted that there is nothing normative in the discussion above on the role of the nation. Even if the nation-state, or even the region, may facilitate learning and innovation, the cross-border harmonisation may in some cases be beneficial, or even a pre-requisite, for utilising the diversity of nations in a manner promoting innovation (Johnson & Gregersen, 1997). Although their position on this is a bit unclear, Johnson & Gregersen (1997, p.55, 69) point to the patent system as one clear illustration of this argument, as is illustrated in the citations below:

> Compatibility between institutions at the national and the European level is a key issue in the whole integration process. The development of a European patent system is a clear illustration on this. From its origins, the registration of a patent took place within a national legal system reflecting national specific regulations on intellectual property rights. Spurred by the ongoing European economic integration and the creation of the "Single Market" the European Patent Office (EPO) was established under the Munich Convention of 1973 in order to facilitate industrial protection based on a unified system of registration, which ensures the protection of inventions simultaneously in several European countries. When an inventor wish to protect an invention in several European countries it is sufficient to file a single application to the EPO, which then is empowered to deliver a centralised agreement covering all the designated countries in the request, while the protection of the patent itself still depends upon the specific national regulations of each designated country. However, within the Community efforts (based on the EU Patent Convention from 1989) have been taken towards a common EU patent system in the strict sense. The intention is to build a unified legal and administrative system, where a "EU-patent" is assigned the same legal status inside the whole EU area." (p.55)

> " A diversity of innovation systems may be a prerequisite for safeguarding innovation potentials in Europe. Every attempt to build a European system of innovation should take this into account. However, convergence between national innovation systems in some respects, for example in terms of intellectual property rights, communication channels, administrative routines and technical standards may be a prerequisite for utilising other aspects of the diversity." (p.69)

Even if a firm conclusion should not be derived solely from these statements, one may learn from this that harmonisation should not necessarily be an end in itself. It may be so in some areas, but it should be considered carefully which areas should be harmonised and which should not[21] (In chapter 7 we shall return to this discussion with the patent system).

In this connection, it is important to see not the nation-state as a static entity. Even if physical borders do not change much, then the nation-state is part of a dynamic world in which some of the above mentioned processes of internationalisation affects the meaning and functioning of nations. It has been argued (Ohmae and others) that the nation-state is loosing importance as a consequence of globalisation and harmonisation. However, it may be argued that precisely because of these processes of globalisation and harmonisation, the nation, or even the region, is gaining still more importance. As still more framework conditions are harmonised across borders, all firms have the same regulatory, financial, and informational market conditions. This means that to have a competitive edge firms cannot compete on these parameters, as they are approximately the same to everybody. Instead, a competitive edge must rely on tacit knowledge. As tacit knowledge is most efficiently created and transferred in a close interaction between the parties, cf. above, which means it is best produced at a regional level. The simultaneous processes of globalisation and still stronger importance to the regional, or local, level is sometimes referred to as "glocalisation". The mechanisms behind these processes may perhaps explain partly the agglomeration trend that is a tendency for firms producing similar products to locate close to each other[22]. The Marshallian explanations

[21] The implementation of the European Currency Unit is probably the best known example. Not all joined every step of the ECU-project. Even if this issue is well researched it is still subject to controversies.

[22] Numerous examples could be mentioned. The most famous is probably Silicon Valley. Others include IT in Kista and Aalborg. Northern Italy is likewise often mentioned as an industrial district.

of such "industrial districts" as benefiting from among other things factor conditions and a large pool of specialised, qualified labour, is still valid. But one should also add the exchange of knowledge as an essential element.

2.7 Implications

In this final section we shall briefly state some of the most important implications, derived from the above theoretical development, for the further steps of the present study.

Even if the patent application process to a large extent is about handling codified knowledge, then there is – as emphasised earlier – also tacit knowledge involved in how to organise and undertake this application process. Some of the potential learning between the parties is no doubt possible to mediate by way of simple transfer of codified knowledge. However, we need to investigate whether the tacit element in the knowledge transfer is substantial. This element, it was pointed to above, may be stimulated by proximity of various factors, geographical, cultural, language. This constitutes a second issue to pursue in the further study.

This was also one of the main points in the tie-strength discussion: in case of transfer of pure codified knowledge there may be no need for strong ties. In that case, in principle the patent granting authorities could be physically located anywhere in the world. One may even argue that precisely because of this, these authorities could equally well be decentralised in order to have the possibility to benefit from spillovers from the patent examiners, and other patent office staff. Related, the discussion on the nation-state as a framework for innovation processes and learning pointed to the need to explore in more detail what are the pros and cons of the physical location of national institutions such as the patent offices. As was mentioned, the location could be decentralised or centralised, as patent applications are largely codified knowledge. However, because of the codified knowledge the location, in theory, could be decentralised. It is though a normative and practical problem if this should be the case. Moreover, this question also depends on whether the processing of patent application (and the technical expertise involved) is related to other activities of patent offices. Later we shall address to this issue.

A fourth implication of the theoretical discussion is that preparing the patent application involves transformation of tacit knowledge to codified knowledge in a language, which is understandable for the receptor. This is a difficult process, and for patent offices playing a role in building up the general innovative competencies of firms it may be essential that they are skillful in guiding firms in how to transform their tacit knowledge into codes that may be managed in a patent.

A fifth issue is the theory discussing the importance of the intensity/frequency of interaction between the parties in facilitating this mutual learning. The argument says that this interaction stimulates build up of mutual trust and codes of understanding, which in turn are very important to learning. This points to the need of further investigation of this aspect of the patent granting process. As was pointed out in chapter 1, this has several links. We may point to the interaction between patent examiners and other staff of the patent office, in particular the Sales & Marketing department. As was discussed here, the intra-organisational knowledge flows are immensely important to take into account. In order to be efficient, it is most often required that such knowledge flows are deliberately stimulated by internal organisation (tacit knowledge) or management/information systems (codified knowledge).

Finally, the theory introduced the concept of knowledge spillovers, or in other words, to what extent is the learning produced specifically related to the one-time application, rather than being generally useful[23]. If knowledge spillovers are close to nil, the diffusion effects of the learning is likely to be minor. This is an important aspect in further investigations.

[23] In fact, transaction cost economics implies similar conclusions as this theory points to the asset specificity of the good or knowledge as being decisive to the way it is traded.

3. Institutional mapping of the DKPTO in the Danish innovation system

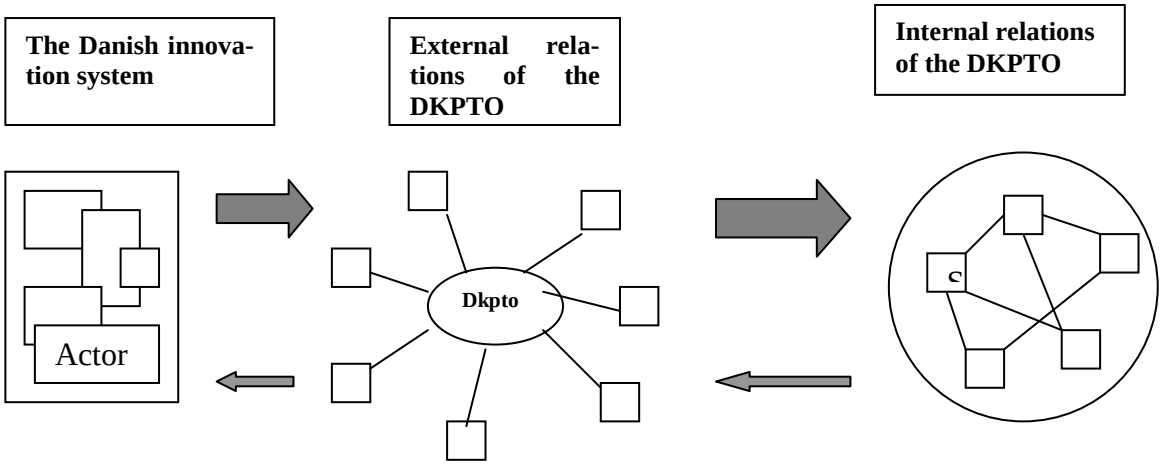
3.1 Introduction

After having established the theoretical background for this report we proceed in this chapter with a description of the Danish innovation system with special emphasis on how the DKPTO should be placed. It was argued in chapter 2 that the environment in which the learning processes take place is important for the outcome. This goes not only for interaction on the micro-level. Earlier research has shown that the national boundaries, and how the learning processes are institutional embedded matter for the interaction between the parties. Therefore, the placement of the DKPTO in the overall innovation system is not trivial; rather it is important to the understanding of the functioning of the DKPTO.

The method for doing this is to make clear what are complementary institutions in the innovation system. Included in that section is a discussion on what are the sources of inspiration to innovation in Danish firms in general. That section (3.2) draws upon statistics from innovation surveys. The following section (3.3) outlines the relationships between the institutes in the national innovation system and the patent office. Finally, in 3.4, the institutional mapping is put into perspective for the development of innovation policy in Denmark. This is done in order to show the dynamic setting in which the institutional framework evolves.

With this structure, research on different levels of aggregation is pursued. Moreover, the research may be seen as closely connected with that of chapter 4, in which we focus on internal relationships. Thus, the discussion presented here can be described as a "stepwise" reasoning in explaining the possible connection between the internal relations (i.e. the technical) knowledge and competencies of the DKPTO, the external relations with other actors of the innovation system, and the innovation system in general. This is illustrated in fig. 3.1., in which the left-hand side box contains the actors in the Danish innovation system with (partially) overlapping activities (will later be exposed as figure 3.2.). The middle figure shows the relations between the DKPTO and other actors (explained in section 3.3), and the last part of the figure illustrates the intra-organisational relations within the DKPTO, for example between S&M and patent section.

Fig. 3.1. Linking internal and external relations of the DKPTO.



A special feature of this model of the DKPTO and the Danish innovation system is that it is purposed that relationships go both ways. The Danish innovation system influences the external relations of the DKPTO, which in turn affect the internal organisation, processes, and knowledge diffusion of the DKPTO. Depending on the extent of the activities of the DKPTO (i.e. the number of patent applications filed and the demand for business services) the innovation system is also affected though on a smaller scale. This is illustrated by the size of the arrows.

3.2 The national innovation system

As was indicated in chapter 2 a system of innovation is a system of companies, consumers, institutions and politicians who interact with one another in such a way that new knowledge is diffused and applied with innovations being generated. The innovation system consists of a number of players, which through their resources and activities influence the innovation system. The players will influence the speed and direction in which the innovation system is moving and they will influence the relationships and interactions in the system. The national innovation system is an open system but at the same time each particular system has a degree of autonomy in it interactions with the outside world when it comes to its way of function, progressing and specialising. The system can be characterised by the way of specialising, by institutional structure and its connection to the outside world (Lundvall, 1999:41).

It becomes obvious when studying the national system of innovation that the nation's ability to innovate is not only depended on how the individual innovating organisations such as companies' R&D department and research institutionsoperate he national system of innovation is also determined by how the research entities co-operate with each another and with the public sector in questions of knowledge diffusion and knowledge creation. Knowledge and innovations are strongly related and knowledge transferring therefore becomes central in the discussion of the innovation system.

The important of knowledge diffusion is not only with new technology or products. It is also essential to the transfer of knowledge that enables companies to develop market-driven innovations themselves in-house and so expanding their own innovative potential. Knowledge diffusion happens between various channels internal, externally, formally, as well as informally.

Innovation surveys may reveal what are the information sources for innovation. A Danish innovation study (Christensen, J.L 2000) reviews selected Danish innovation surveys over the past decade. The three innovation surveys reviewed show a stable pattern of what information sources are the most important.

For the most recent survey (covers the period 1994-1996) the table below show the ranking of different sources of information.

Table 3.1 Information sources for innovation – share of firms who state a source to be of large importance. By sector. Percent.

Information sources	**Manufacturing (N=214)**	**Service (N=90)**
Clients or customers	40	46
Sources within the enterprise	34	32
Competitors	13	23
Suppliers of equipment, materials, components or software	12	23
Fairs, exhibitions	9	10
Informal network (colleagues, friends)*	9	7
Other firms within the enterprise	7	23
Patent descriptions from others	6	12
Consultants	3	11
Universities or other higher education institutions	3	1
Government or private research institutes	2	1
Conferences, meetings, journals	2	8
Computer-based information networks	1	12

** This question is special for the Danish survey.*

Sources such as *customers* and *sources within the company* turned out to be of greatest importance. Other less significant information sources for innovation mentioned were competitors, suppliers of equipment, components, material and software, exhibitions and other companies within the parent company and others' patent descriptions. A relatively small percentages of the firms answering the questionnaire, also mentioned sources such as private consultants, universities, research institutes, conferences, journals and computer-based information network as being important. The size of the company and its products will to a large extend determine which sources are the most useful. Another Danish survey on innovation and information sources from 1994 concludes that the high tech

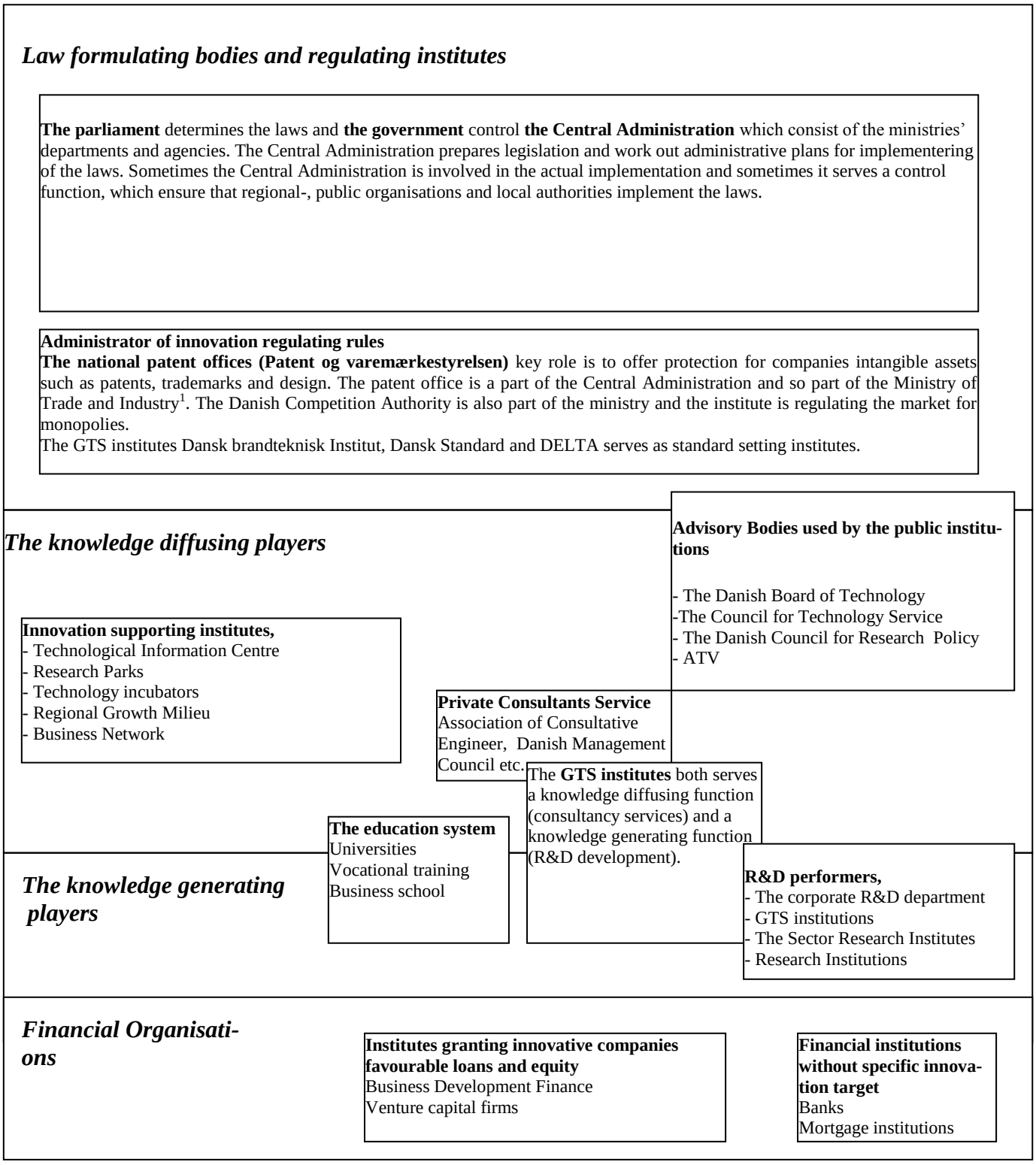
companies use a wide range of different information channels for innovation purpose (including contacts to universities), while the medium- and low tech companies uses fewer different sources. However, the medium- and low-tech firms to a larger extend make use of the technological service system in comparison to high tech companies (Christensen, J.L., 1994).

Exchange of technological knowledge does to a large extend take place within companies and between private companies, particularly in the networks without public institutes. In this particular mapping of the Danish system of innovation, the knowledge diffusion players include consultancy services, public institutes promoting innovation, and public institutes promoting knowledge diffusing. Knowledge transfer between players such as suppliers, customers, competitors and the like are not included. Likewise, even if capital is often mentioned alongside technological knowledge as a precondition for innovation, then our examination of capital supply is limited, even if some knowledge relevant for innovation indeed is diffused through financial intermediaries.

The figure overleaf shows selected[24] formal innovation promoting institutions in the Danish innovations system (see section 3.3 for further information on the DKPTO and its relations in the national innovation system).

[24] This term indicates that we do not intend to provide a complete picture of the national innovation system. For example we recognise that education of candidates and employment is probably the most important knowledge diffusion mechanism. However, we have not made a detailed describtion of neither the education system nor some of the other institutes relevant to knowledge diffusion such as financial institutes and labour market.

Figure 3.2 Description of selected institutions[25] in the Danish national system of innovation



[25] The corporate R&D departments' part of the entire R&D activities in Denmark is roughly 50%. Which makes the private companies a main player in the national innovation system. As mentioned before the focus of this report is first and foremost on the formal innovation institutes. Therefore, the firms are not included in the figure.

3.2.1 The Parliament and the Central Administration

Most of the political decisions influence to a certain extent the level of innovation. Therefore, it becomes necessary to regard the national innovation system from a broad perspective. It is not enough to discuss to which extent implementation of the business policy influences the R&D system such as public R&D subsidies, and government direct involvement in R&D etc. As emphasised by, e.g. Lundvall & Borras (1997) and Lundvall & Christensen (1999), in order to get a complete picture of the role of government in innovation it is also necessary to include considerations that can have an indirect impact such as human resources. Thus, a broad and more complete picture of the national system of innovation will require the examination of factors which indirectly determine the level of innovation such as flexibility among the personnel and formal skills are included. The innovation system is much more than the physical R&D output, so the definition of the innovation system must likewise be extended to include considerations of human resources (Lundvall & Christensen 1999). In continuation of this perspective it becomes clear that policies within areas such as education and labour market must be included in the innovation policy debate.

Parliament determines the laws, with the politicians setting up the basic framework for innovation. The government is subsequently responsible for the execution of the laws and the Central Administration implements the laws (the department and the agencies). The Central Administration also prepares legislation and prepares administrative regulations for the implementation of the laws. Sometimes the Central Administration is also in charge of implementing the laws and sometimes they are responsible for ensuring that the regional, public organisations or local authorities implement the laws.

One must accept a broad perspective on the innovation system, because it is no longer sufficient just to consider business policy and business policy initiatives for promoting innovation. As will be discussed in further detail later, labour market policy, research policy, educational policy, as well as fiscal policy and others will likewise be important to innovation and must be included in a full description of innovation policy. So, it becomes necessary to include a wide range of different policies in the discussion of the innovation systems.

3.2.2 Advisory bodies used by the public sector

Each ministry uses public and/or private councils for advising services in the preparation of legislation. Part of The Ministry of Trade and Industry is *The Council for Technology Service* and part of The Ministry of Research and Information Technology is *The Danish Council for Research Policy*. In addition to the public advisory bodies, there is a large array of private advisory bodies. The private organisation *The Danish Board of Technology* is for instant serving The Ministry of Research and IT.

The Council for Technological Service

In 1996, The Danish Parliament and The Danish Government established *The Council for Technological Service* to assist The Ministry of Trade and Industry. The intention of the council was to ensure continuing future progress of technological services.

The council for technological service works as advisories body and handles the overall planning and coordination of promoting technological services in Denmark. One of the councils' important tasks

is to guarantee that the technological service institutions *The GTS institutes network* has the right competencies and works as originally intended. The council fulfil the task by being involved in the handling of grants for research activities for the GTS institutes (see section *Public Grants for Innovation Projects*).

The Danish Board of Technology
The Danish Board of Technology is a private organisation affiliated to the Ministry of Research and Technology. The council formed in 1995 is primarily a debate forum on technology issues and the organisation's main task is to influence the public debate. The issues debated focus especially on technology and ethics and on the effect of new technology in the society such genetic engineering.

Besides being a debate forum, the councils also guide the government and parliament in technology issues. By doing so, the council does have an impact on innovation, although this impact is largely indirect.

The Danish Council for Research Policy
The Danish Council for Research Policy is part of The Ministry of Research and Technology and was established in 1996. The council's most important job is to guide and advise he Ministry of Research and IT, as well as the rest of the parliament in important matters concerning national as well as international research, including which research policies to implement. Besides the Danish Council for Research Policy there are also a number of councils, which serves the Ministry of Research and IT, providing policy advice on specific research issues.

The Danish Council for Research Policy also contributes to co-ordination of counselling on the interaction between public and private research.

ATV
ATV is a private institution with almost 630 members. The academy is a forum for debate between researchers and private companies with interest in technology. It is an organisation where new thoughts and projects for promoting Danish research and technology are debated. ATV's' main objective is to promote technical research and development and the application of research results.

3.2.3 Advisory bodies used by the public and private sector

Private Consultants
The private consultancy sector is primarily directed towards the private sector. The private consultancy business make up a large part of the entire advising service system and the customers of the consultants are private companies as well as public institutes.

A large part of technology consultancy is organised in the business organisation The Association of Consultative Engineer (FRI). In 2001, FRI had 350 organisations as members and covered consultancy services within all the engineering disciplines.

The member companies' revenue comes from sale of consultancy services on the market. Almost half of the member companies' revenue comes from services sold to the public sector (among these contract projects).

Besides the technical consultancy, there are also a number of consultants, who sell consultancy services within the field of marketing, management and legal advice. However, the management con-

sultants primarily offer services within areas such as management development, organisational development, project management and PR. Some of the management consultants are organised in the organisation Dansk Management Råd. In 2001, 4000 consultants were employed in the management consultant sector.

3.2.4 R&D Performing institutes[26]

Research Institutions
The research institutes serve two key functions to society. They provide basic research and educate candidates. The research institutes are placed at the universities and other higher educational institutions and most of the research carried out by the research institutes is publicly funded.

The Sector Research Institutes
The main objective of the Sector Research Institutes is to contribute with knowledge, which is useful in a public context or for private purposes. The institutes are supposed to provide the nation as a whole with useful knowledge and a large number of these institutes are completely government funded. However, there is great difference here among the institutes. For instance Dansk Serum Institut and Risø sell consultancy services and receive a considerable part of their revenue from these activities.

The Sector Research Institutes are national institutions, which has research and development activities as their main task. Discoveries are exposed in scientific publications, at conferences etc. Today there are 26 'independent' institutes and each institute is affiliated to a ministry, which is responsible for the institute. The Ministry of Research and Information Technology is responsible for the Institute Risø whose primary task is to conduct research within the area of nuclear energy.

GTS institutes (Approved[27] Technological Service Institutes)
The GTS institutes are independent research bodies with the aim of passing on application-oriented technical knowledge to the Danish companies and the public sector, as well as some creation of new knowledge.

There are twelve GTS-institutions in Denmark today and each institute is covering a specific area of technology. The *Biotechnological Institute* (BioTechnological Institute) is for instance the biggest supplier of R&D and consultancy within the field of provisions and biotechnology in Denmark. Another example of a GTS institute with a broader technological field is the Danish Technological Institute. This institute covers a wide array of issues from management consultancy to Environmental issues.

The GTS institutes are typically involved in several or all of the following activities,

[26] The private companies in Denmark carry out a large part of the total R&D and much knowledge diffusing take place when the companies interact. However, focus is here on the supporting knowledge diffusing institutions so an examination of these inter-firm knowledge flows is left out.
[27] The GTS institutes sell their services on normal commercial terms. They do though, have non-profit objectives and therefore the government co-funds some of their activities as well as abstain from demanding taxes. Approved refers to that the institutions can apply for co-funding of competence building activities that will enable them to supply the latest technological knowledge to enterprises.

Research and development, Most of the GTS institutes have their own R&D-departments where they carry out research on commission for private companies or public institutes. The GTS institutes might also cooperate with private as well as public institutes in projects.

Teaching, Some of the GTS-institutes offer in-service courses within their specific technological field and some of the institutes give courses in management, organisation, or IT.

Consultancy Service, The GTS institutes offer consultancy services, which are their primary source of income. The consultancy service will typically be technical application-oriented knowledge.

Testing and control, Some GTS-institutes conduct test and issue certification, such as the testing of the quality and capacity of an invention. In addition, some of the GTS institutes make routine inspection. An example would be the DHI - Institute for water and environment that controls sewage by analysing samples.

Standardisation and certification, Several of the GTS-institutes are authorised to judge and give approval to companies applying for certain certificates. For instant, the GTS institute *Dansk Standard* is the main Danish institute for standardisation. Dansk Standard has the authority to issue certificates such as ISO, IEC, CEN and CENELEC.

The GTS institutes are primarily funded through selling consultancy services to the public as well as private customers. In addition, they receive public support for research and other competence upgrading activities through result contracts.

Result Contracts
The Council for Technology Service (part of the Danish Agency for Trade and Industry) enter into a three years contract with the individual GTS institutes. The contracts can be considered long-term strategic investment in knowledge and competences for the state. At the same time it allows the GTS institutes to build up know how, within areas where there are no immediate commercial interest.

The GTS institutes apply for the contracts and in the application they outline details for the competence areas they want to focus on. The result contracts include an exact specification of the projects to be carried out with detailed descriptions of the output, quality, and price. In year 1999, the institutes had a total revenue of DKK 2,2 billion. Of this, support from government amounted to DKK 240 million or 11,2 % of their revenue revenue.

3.2.5 Property and Standardisation regulating institutes

In many cases, it is important for the innovator to protect an invention and the protection of intangible assets is partly considered a motivating factor for their continuous involvement in innovation activities[28]. It is also important that the society has rules for standardisation in order to protect the consumer and help companies prove their products have a certain level of quality. So it becomes

[28] There are other ways of appropriating returns from innovation than taking out a patent. Companies also choose strategies such as lead time advantages and secrecy. A survey conducted for Dkpto shows that out of 451 respondents from SME manufacturing companies 61% used lead-time strategy as a way of protecting innovations. 54% used secrecy for protecting innovations, 42% used registered trade marks, 42% used restricted clauses with employees and 38% use patents (IFO, 2000).

necessary to have certain regulation on products such as patents and standardisation to promote innovation.

The Danish Patent and Trademark Office (DKPTO)
The Danish Patent and Trademark Office key task is to offer protection for inventions, trademarks and design. Furthermore, the office also offers consultancy services such as information services, guidance and training within the area of industrial property rights. It should be noted that the role of the DKPTO in the innovation system depends on a number of different activities including trademarks, design, and copyrights. However, in this context (as throughout this analysis) the focus is on IPRs primarily relating to patents. In other words, focus is on the role of the DKPTO in the innovations system by virtue of its activities relating to patenting.

In 1999 the DKPTO received 1674 Danish patent applications (of which about 400-500 are likely to result in the granting of a patent) and 221 foreign (DKPTO, Annual report 1999). In the same year the EPO received 34.932 patent applications applying for patent in Denmark and 592 of the applications were from Denmark (EPO, annual report 1999).

The patent office is a government institution, but is financially independent (non-profit) and today no subsidies are given to promote relationships between the office and the other actors within the innovation system.

The patent office does provide services to the actors in the national innovation system. First of all the Patent Office issue patents to individual firms, the GTS institutes, Technology Incubators and Research Parks. The patent office also offers courses on how to apply for patents at several of the regional Technological Information Centres and at universities. In addition, the office sell different analyses such as competitor analysis, market analysis and the DKPTO can help to investigate whether a patent has been violated. The consultancy services are sold to private companies, technology incubators and research parks, the business orientated GTS institutes. Sometimes the Sector Research Institutes and the Research Institutes use these type of services though it is however rare.

The patent agents are competitors of the patent office on based services. Of course, they do not have the right to issue patents and trademark but they operate within the same business service areas as the patent office. In addition, the patent agents often sell their services such as courses, market analysis, searches on prior art etc. in competition with the patent office. Even if the patent agents are competitors the patent agents are at the same time customers and collaborators. The patent agents' main job is to help patent seeking companies to write applications and lay down a proper patent strategy. As is clear from this description there is some overlap between the work of patent agents and that of the DKPTO (see section 3.3 for further comments on the DKPTO and its relations).

Standard Setting Organisations
As mentioned before, it is the *GTS institute network* in Denmark that works as **standard setting** organisations. The standard setting GTS institutes are Dansk Brandteknisk Institut, Dansk Standard and DELTA.

3.2.6 Innovation Supporting Institutes

Technological Information Centre (TIC)

The TIC centres are regional information and consultancy centres and they provide information to local small and medium sized companies SMV[29] within the areas manufacturing, entrepreneurs, technology based crafting and knowledge based services.

The TIC centres offer free introductory consultancies to newly started SMVs' and help companies implement and carry through different innovation projects. The centres offer individual support on issues such as establishment of company, progress etc. In addition, the TIC can help establishing contact to the right experts and knowledge centres. The TIC centres also offers cheap office space and access to conference room etc. for start- up firms.

The TIC centres are independent and sponsored by The Ministry of Trade and Industry and local authorities.

Research Parks
The individual research parks' overall purpose is to promote and support innovate companies and contribute to regional knowledge diffusing. The Research Parks fulfil this job by lending out offices, laboratories and other facilities. In addition, the Research Parks help the innovative companies with network contacts and guidance.

The five research parks are closely related to the Danish universities and the other research parks. The research parks build up networks between companies inside the Research Park as well as networks to the outside world and it is one of the main aims of the research parks to promote these informal type of networks.

The Research Parks are today independent corporations originated from public initiative. The parks received public grants for establishment but are today self-financed. The parks main income is from consultancy services and rents from the companies using the parks' facilities.

Technology Incubators
A technology incubator is a regional co-operation agreement between research parks, which are running the incubators, a GTS institute, financial institutions and newly established companies. The objective is to bridge research environments, innovative entrepreneurs and finance companies in order to develop and transfer research and innovative ideas to commercially sustainable innovative projects and enterprises.

What differentiates the Technology Incubators from the traditional science parks or Business Innovation Centres is that they provide both knowledge and capital for innovative entrepreneurs. Thus, the overall purpose of the Technology Incubators is to support new, small innovative companies in Denmark by securing a close interaction between innovative entrepreneurs, research and capital in the development of new products and services.

The target group of the Technology Incubators is innovative entrepreneurs with a knowledge-based idea with a commercial potential. Established companies are not eligible to receive support from the Incubators. The Technology Incubators offer knowledge, advice and seed capital to companies during the initial phase of development; i.e. before the company has developed an actual concept, product, or service. After this phase the Technology Incubators may assist the company in obtaining

[29] A SMV is a company with less than 250 employees and revenue less than 300 Mio DKr.

capital, e.g. through the state-owned fund, Business Development Finance, from venture capital companies and/or individual private investors.

The Ministry of Trade and Industry supports these incubators, and in the period 1998-2000 a sum of DKK 310 million (EUR 42 million) was assigned for the initiative. After a positive mid-term evaluation in late 1999-beginning of 2000, the program was recently extended for another three years. After this period the government subsidy will stop. The Danish Agency for Trade and Industry is responsible for the administration of this venture scheme.

Regional Growth Milieu
A regional growth milieu is established when regional players such as a company, a university, a technology institute and other relevant regional players decide to co-operate on a research project. The idea of the regional technology incubator is to strengthen and intensify the relations of co-operation between the parties participating and in that way contribute to new knowledge within areas such as technology, or IT. A main idea of the milieu is to transfer knowledge from universities into more application-oriented knowledge and ensure that new knowledge becomes a part of business development.

The regional growth milieu can receive up to 60% public funding and the administrator of the milieu is one of the players.

Business Network
The business network is an example of a new type of co-operation between universities and private companies. The main purpose of the business network is again to couple the university research with private companies, who operate within the same field. The networks are supported administratively by the universities' network centres. Aalborg University is for instance administering 35 different networks within such areas as ITC, Human resources, design and others[30].

3.2.7 Public grants for innovation projects

The Ministry for Trade and Industry has several tools for promoting the establishment of innovative projects. Three of the tools are *result contracts (see the section on the GTS institutes), development contracts* and *centre contracts*. The contracts are administered by The Danish Agency for Trade and Industry (part of the Ministry of Trade and Industry) and the Council for Technology Service.

The Centre contract
It has been a general trend in Danish innovation policy to turn focus away from single, isolated elements of the conditions for innovation, and in stead enhancing the coherence of the different elements in the innovation system. The Centre contract-scheme is an important example on such policies as it gives incentives to bring together key actors in the system. Thus, the objective of the scheme is to intensify the corporation between universities, private companies and the GTS institutes.

A typical centre contract involves 3-4 private firms, 1 Authorised Technological Service Institute and 2 research institutes. The contracts typically last 3-4 years. Compared to the population of firms in general the firms participating in centre contracts are most often large. This may be explained by

[30] See further information on www.nc.auc.dk.

the fact that a formalised contract requires a substantial amount of resources. In addition, the firms must be at a certain scientific level if the GTS institutes and Research Institutes are to find the firm an attractive partner for collaboration.

The centre contract scheme is unique in the sense that it brings together all three parts of the system, not just two of them as in several other schemes. The Government funds available for the scheme were 85 mill. DKK in the year 2000.

The Development Contract
A development contract is a binding contract, where a public institution and a private organisation engage in co-operation. The parties involved in the contract must be public institutes and private companies. The purpose of the development contract is to convert the public knowledge and expertise into commercial knowledge in private companies. The public partner can be a ministry, a local authority, a university or some other entities.

There are two types of development contracts: *commercial contracts* and *public utility contracts*. The commercial contracts are signed, when a public institution needs a product or a service to be developed or developed further. It is a type of contracts where there is no specific public demand for the good, but where a public institution believes that the project can be of importance for Danish businesses.

Part of the project can be financed with public funds and it is the Danish Agency of Trade and Industry who administer the contract. However, it is only the public institutions that can supply for the funds. In addition, the private companies must be the ones to take the initiative and as well as finance 50% of the project.

Business Research Contract
The Business Research Contract is a public program, which provides grants to education of new researchers (PHD) who work for a private company and at the same time is affiliated to a university.

The Business Research Contract is a public program which main purpose is diffusing of knowledge and commercialising of the results from academic research. ATV administers the program.

3.2.8 Venture capital

A precondition for innovation is capital and for many new companies, which makes it even more a barrier for SMEs. Therefore, there have been established different public initiatives during the 90s to ease the access to capital.

Business Development Finance
The Business Development Finance was established in 1992 with the purpose of improving small innovative companies' access to capital.

The Business Development Finance supports SME innovating Danish companies by helping to finance R&D projects, competence development and internationalisation. The loans are granted with security in the project. Recently BDF has changed strategy and is now also engaged heavily in equity instruments and funds-of-funds.

Development Companies
In 2001, there exist 17 development companies in Denmark. The development companies' overall function is to support SME with capital and consultancy and general assistance concerning management and organisation. The development companies operate in general at market conditions, but they also receive a state guarantee that covers a maximum loss up to 50%, if a project fails.

The development company is a business policy project, which was established in 1998. The purpose of the project was to ensure new innovative companies have access to capital supply and competence guidance in management and organisational matters.

3.3. External relations: the DKPTO in the Danish innovation system.

3.3.1. Introduction.

In the preceding sections (3.2.1. – 3.2.8.) a number of important actors and institutions in the Danish innovation system have been identified along with brief descriptions of their functions / roles. In order to draw a clearer picture of the possible role of the DKPTO we need to place the DKPTO on this "map" of institutions focusing on it's main "partners" and "customers" in the innovation system.

The activities of the DKPTO are part of this system and of the framework conditions for innovation in Denmark. However, not all of the actors and institutions mentioned in the sections 3.2.1 – 3.2.8 have relevant contacts with the DKPTO and the external relations stipulated in fig. 3.3. only comprise some of them. Therefore the purpose of this section is not to analyse the different types of relationships and "partnerships," in which the DKPTO is engaged, it only provides a general description of its main relationships with other actors is provided.

The position of DKPTO in the system is not only a question of whether or not (technical) knowledge is diffused and adopted by innovators with the effect of directly boosting concrete technological innovation. As indicated above, the Danish innovation system is a complex system of interacting institutions. The descriptions that follow are not solely focused on technological innovation.

3.3.2. Linking services and actors.

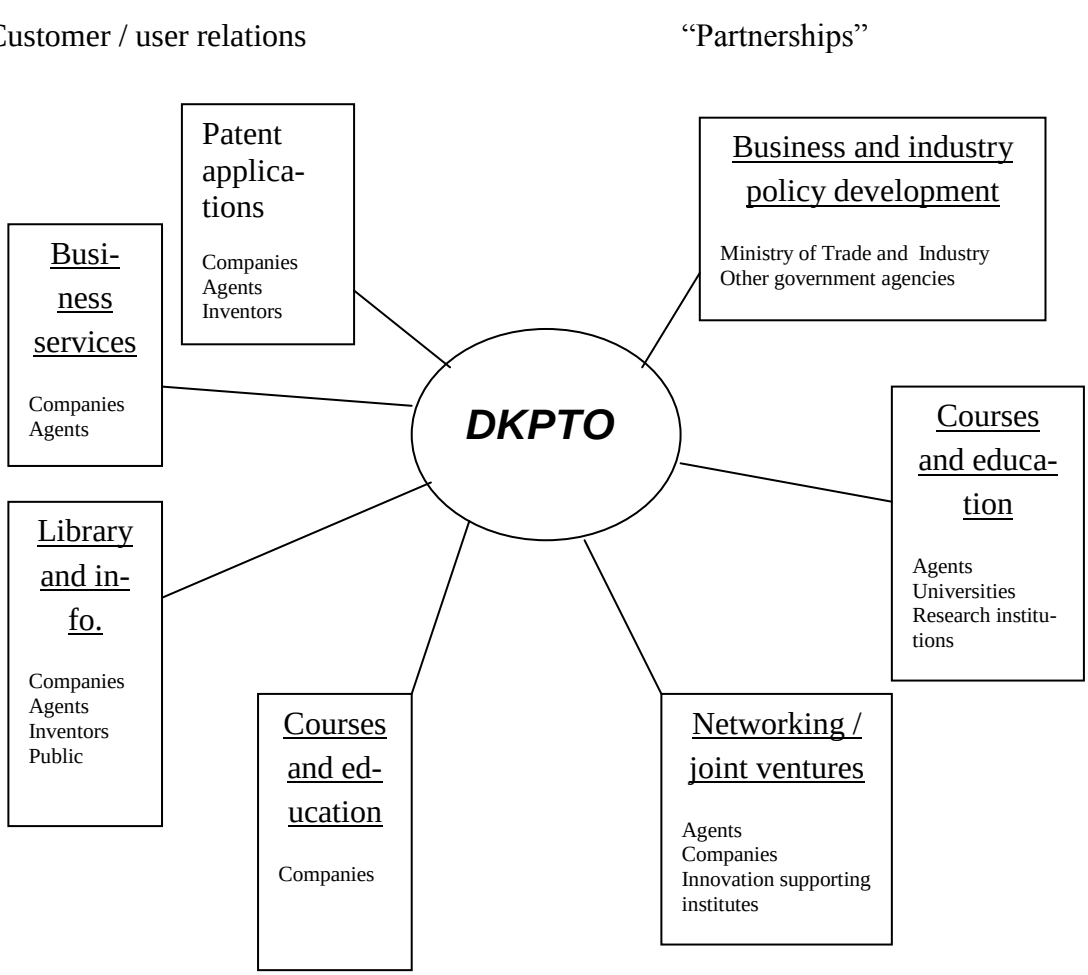
Apart from the activities that are directly linked to the issuing of patents, some DKPTO-activities may overlap those of other actors in the Danish innovation system. Ways of interacting may be characterised by two main types of relationships:

- Customers / users relations
- Partnerships.

These different types of relationships are associated with different kinds of activities, some of which have already been mentioned in section 3.2.5. Although the distinction stipulated here might not be absolutely clear-cut, the customer / user relationship mainly involves activities such as handling of patent applications (search and examination), business services, and other services (library services and general information). Partnerships involve activities concerning, e.g. IPR education, courses, networking, conferences, meetings and various industry policy projects and initiatives.

Customers / users are mainly companies and patent agents while partnership activities mainly involve other public and private institutions operating in the field of innovation and industry policy. However a number of actors are engaged in both customer / user relations and in partnerships at the same time and accordingly they are represented on both sides of fig. 3.3. This figure fits well into fig. 3.2 as a part of the general innovations system in Denmark, only the focus is here specifically on the DKPTO's external relations.

Fig. 3.3. External relations of the DKPTO.



Partnerships:
Partnerships that are relevant to the Danish innovation system mainly include activities concerning general business policy development, IPR education, and networking activities that facilitate communication between different parts of the IPR branch (e.g., between agents and companies). Important partners can be found in particular among advisory bodies (3.2.2), R&D performing institutes (3.2.4), innovation supporting institutes (3.2.6), and other government agencies.

In the field of business and industry policy the DKPTO is a partner to the Ministry of Trade and Industry and to the other government agencies that are part of the Ministry (e.g., the Danish Commerce and Companies Agency and the Danish Agency for Trade and Industry). For example, the

DKPTO and the Danish Agency for Trade and Industry have joined forces in conducting a project concerning how to evaluate intangible assets.

Networking / joint venture activities include establishing of conferences such as the "NKT conference", which is a joint venture between the DKPTO and a major Danish company (the NKT) with a strong interest in IPR. The aim of the venture is to reinforce co-operation. Regular "user meetings" (where customers meet with the DKPTO and discuss matters of mutual interest) are also an important part of networking activities.[31]

The relationship to the patent agents is explained in more detail below as an example on the external relations.

The "joint communication project" is a joint project between the DKPTO and patent agents. This project aims at developing and improving the use of IPRs by Danish companies when developing and marketing new products. Thus, the patent agents and the DKPTO have a common interest of increasing the knowledge of IPRs in general and of the products offered by the agents. The establishment of this project, however, has also revealed that many patent agents are reluctant to enter closer relationships with the DKPTO since they see themselves as competitors. It is of course true that the DKPTO could potentially compete with agents in a very direct manner as they offer many of the same type of services. The difference lies particularly with the fact that the DKPTO is not allowed to engage in the same type of close consultancy as the agent, first and foremost because the DKPTO only has a very limited right of guiding applicants on how to formulate the specific claims of the application. However, in the field of patent strategies and novelty searches the DKPTO does to a certain extent act as a competitor to the agents. Because of these built-in overlaps in the activities of both parties, a "common understanding on competition" ("Borgfreden") has been made between these two parties. This leaves distinct areas of counselling to the patent agents.

The common understanding on competition have made it possible to focus more on common interests in developing the IPR branch and diffusing knowledge on the economic importance to companies of protecting new products. The joint communication project (to be launched under the name of "Profitgate") aims at doing exactly this. Profitgate is established as a joint project between some of the major patents agents operating in Denmark (Albihns, Chas. Hude, Hoff-Bang Zacco, and Plougmann & Vingtoft) in close co-operation with the DKPTO. The central activities in this joint initiative include discussion meetings at companies, direct contact to specific companies, background articles in the press, participation in media debates, and the establishment of an Internet homepage.

Besides this, the agents constitute a major group of customers to the DKPTO. Around two-thirds[32] of the applications filed at the DKPTO are filed via a patent agent. This normally means that most (if not all) communication goes through the agents, who accordingly are the main customers to a range of the services offered by the DKPTO.

[31] In chapter 6 we explore to what extent firms think they help Dkpto increase their ability to service customers.

[32] According to the DKPTO's own records and measured by number of applications, a more correct measure of the composition of customers would be the count of the number of customers only as the number of applications differ from customer to customer.

Courses and educational activities are also an important part of the external partnerships. The DKPTO often co-operates directly with patent agents when establishing different courses on technical and legal issues concerning patenting. Initiatives have also been taken to reinforce co-operation with universities in order to incorporate IPR education into existing curricula of especially technical and natural sciences education. (Ministry of Industry and DKPTO, 2001).

It seems that the external relations with patent agents are among the most important of the DKPTO' partnerships. This is perhaps no surprise as they more or less share the same customers. At the same time, patent agents are themselves among the most important customers of the DKPTO.

Customer and user relations:
Besides handling patent applications and granting patents DKPTO activities consist of various services that are essential when using IPRs strategically for business purposes. Thus, the so-called business services constitute the other main part of DKPTO activities. Library and information services as well as educational activities are also part of the DKPTO's customer / user relations. Customer and user relations consist of patent agents, inventors, and companies and these relations are of course a central part of the DKPTO's activities. Library and information services as well as educational activities (courses) are mainly directed towards regular users, but the DKPTO also has a role of informing the general public.

Although the core activities of the DKPTO are focused on the role of the DKPTO as a national authority and is characterised by formal / codified communication relating to the patent granting procedure (see chapter 4 on this), the DKPTO is also obliged to provide the necessary guidance in order to secure the legal rights of the applicants. Besides handling of applications, this area of the DKPTO's activities also includes handling of protests against granted patents and administrative re-examinations. Both these services are important to the users of the patent system as it may lessen the use of lawsuits for settling disputes.

Business services consist of a number of different products designed to assist inventors and companies in R&D activities and in planning IPR strategies. The most important products include novelty searches, infringement inquiries, state of the art inquiries, and analyses of competitors / profile analyses. Library services consist of guiding regular users in using the patent literature and in offering access to on-line and physical (paper) databases with patent literature. The library provides access via EDB terminals and CD-ROM and the library staff is ready to assist in how to use the different media and in finding the relevant (technical) classes for novelty searches. Educational activities, info meetings, and courses are also part of customer relations. As such, the DKPTO offers courses on IPR issues with special relevance for companies R&D divisions and inventors.

Data on these services are not perfect, mainly because individual services often overlap or are "pooled" i.e. they contain different types of services, but are entered as only one service (item). However, some general figures may nonetheless be distinguished. Table 3.2 shows the total revenues by type of activity.

Table 3.2 Total revenues by type of activity (January – September 2000) mill dkk.

Activity	Revenues
Patents	101,4
Trademarks	53,7

Designs	5,4
Utility models	1,8
Periodicals	0,8
Business services	17,9
Courses	1,5
Copy services	1,6
Technical / administrative services	0,8
Other revenues	9,3

Source: 4th quarter Account 2000

Table 3.2. shows that patents and trademarks are by far the most important activities of the DKPTO in economic terms. In comparison, business services are (in economically terms) rather unimportant. Furthermore, the revenue of 17,9 mill. dkk. also includes activities relating to trademarks. Services that are relevant for technical innovation and patenting only amount to about 4.5 mill. dkk. The aggregate figures of table 3.2 are broken down into revenues by type in table 3.3.

Table 3.3. Business services revenues by type[33].

Type	Revenue
Technical service	4.403.517
Monitoring	1.259.992
Bibliographic service	485.998
Trademark service	3.205.720
Databases	59.750
Designs	82.824
EU search	8.353.381
Total problem-solving	17.851.182
Courses	1.497.945
Copy services	1.560.804
Technical / administrative services	788.466
Total business service	21.698.397

Source: 4th quarter Account 2000

Other external relations:
Besides regular customer relations and partnerships, the activities of the DKPTO also influence business life (and the innovation system in general) more indirectly.

Thus, the DKPTO acts as a supplier to the industry of trained patent engineers (see the results of the survey in section 6 for further evidence on this issue). As was discussed in chapter 2 the knowledge embodied in people and the mobility of people is a channel of knowledge diffusion, in this case the industry may be able to enhance its capabilities within the field of IPR by this mobility. The fact that experience from employment in the DKPTO is often mentioned as an asset in job advertisements from companies advertising for patent engineers supports the notion of the DKPTO as a sup-

[33] Here included courses, technical administration, and copy services.

plier to the industry of these competencies. This role can of course only be maintained by virtue of the training and experience gained through the patent casework assigned to the DKPTO.

Furthermore, the DKPTO contributes to technical / professional literature on IPR. This is also a direct channel through which knowledge is diffused in the innovation system in general.

In this section it was argued that the DKPTO is interacting, among others, with the political system and has a role in innovation policy. In order to put the DKPTO properly into the policy picture, we discuss in the next section, first, general trends in innovation policy, then subsequently what is the role of the DKPTO.

3.4 The development of innovation policy and the challenge of designing future innovation policy[34]

It is the intention of this section to give a short review of the development in the Danish innovation policy and to outline the challenges the politicians faces today when determining the right innovation policy, including the managing of the intellectual property system.

After a period of industrial policy dominated by subsidies and big R&D-programmes in *mid-1990s*, it was realised that a new perspective of innovation policies was needed. Rather than one-sided stimulating the supply-side a different perspective was called for, recognising that a top-down guiding of technological development was useless. Previously, during the phase of programme policy, there was a widespread believe that technological development could be pushed in a top-down planned manner. This perception was abandoned with the shift of policies towards setting up the right framework conditions. It was acknowledged that the right framework conditions would vary from company to company and from sector to sector. Therefore, different sector groups consisting of companies, experts, and others were established to help policy-makers identify critical framework conditions and assess the possibilities to improve these factors.

The ability to innovate is increasingly dependent upon different types of institutes outside the companies R&D department like labour institutes, education etc. This constitutes a challenge for policy-making today, as politicians must consider innovation policy from a broader perspective and attention must be paid to the different parties involved in the innovation activities. It is in fact now acknowledged among many policy-makers that the promotion of innovation is increasingly dependent upon different types of policy and institutions (Christensen, 2001).

Due to increasing co-operation between the different players in the innovation system, the globalisation and the development in information technology communication (ITC) the politicians today faces a number of challenges in outlining the right innovation policy.

- It is now widely believed that recent changes in the economy as a whole and more specifically in the way innovations are undertaken has meant an enhanced role for collaboration, co-operation and networking (ccn) in innovation. It is reasonable to expect this trend to continue and be reinforced in the future. Therefore, it is important to support ccn between com-

[34] This section draws heavily on Christensen (2001)

panies as well as between companies and institutes. Given the fact that ccn is a key in industrial development of tomorrow, it becomes interesting to know how it is stimulated. In other words, this becomes a major policy issue.

- The development today is characterised by turbulent, fast changes, which in itself makes innovation policy more difficult. This makes it more necessary to monitor closely the development and to develop flexible, temporary policy instruments.
- Information is generally available, and all countries try to set up the best possible framework conditions. Therefore, the critical success factor increasingly becomes to develop specific framework conditions, which may be useful for only a segment of the market and which may be more soft factors.
- Knowledge is a precondition for innovations and the absorptive ability of firms to incorporate new knowledge is dependent upon the competence of the parties. Therefore, a general increase of competencies will make innovation policy more efficient. This is, however, a difficult policy area, and considerable creativity in policy making is called for here.

DKPTO position in Danish innovation policy

It should be obvious, not least from the list of political challenges, that knowledge diffusion plays a key role in the national innovation system and the knowledge discussion will most likely be central in the future innovation debate. Additionally, the patent system may play an important role because the system both helps protecting knowledge (thus giving an incentive to develop new knowledge), and it helps the diffusing of knowledge in the economy.

Today the Danish companies can protect new knowledge and inventions by using intellectual property rights such as patents. A patent gives a company a temporary monopoly on its product and thus helps to ensure that the product is not imitated. Just as the patents helps the companies protecting new knowledge, the patent system also stimulate diffusion of new knowledge as the patent must be published in the magazine Patent Tidende no later than 18 months after the DKPTO receives the application.

The knowledge from the published patents can for instance be used for research purposes and other companies therefore have the chance to use such knowledge as foundation for new innovations. In addition, knowledge from the patent descriptions can be used as inspiration to new innovation activities. The companies' possibilities of protecting new knowledge and the publishing of patents are the two main arguments for why the state today is supporting the system of intellectual property rights[35].

Organisations such as WTO and EU have contributed to globalisation by reducing taxes and relaxing procedures when trading on markets abroad. This has made the access to foreign markets much easier today. As a result of globalisation and the advancements in information and communications

[35] Nevertheless, there are drawbacks of a patent system as well. It may be argued that the patent system distorts the allocation of resources as certain types of production is stimulated. Other traditional arguments why the patent system has drawbacks is that the monopoly position of the patenting firm render consumer welfare reduction, and that patents block further development of a product or technology. Even if this project is not on the economics of patenting it may be worth emphasizing that assessing pros and cons against each other is extremely difficult. In a literature review Riis (2001) concludes that since Machlup in 1958 claimed that we do not know if the patent system as such is economically beneficial for society, the economic theory have still not reached a conclusion as to this question.

technology (ICT), it has become necessary to adjust the intellectual property right system. It will be an advantage for Danish companies operating at international markets if there were more uniformity in the standards for patent granting in the different counties. Therefore, the government today supports international harmonisation of patent standards and procedures. The government also supports the EPO and a EU patent system. However, at the same time it is believed that fully qualified national patent offices play an important role in the environment for innovation and that is why the government support the idea of the national patent offices as subsuppliers to the EPO. This has been a Danish policy for years now. For example it was stated in the yearly publication on Danish Industrial development and policy from 1995 that a Danish patent authority would still be needed in order to ensure that Danish firms have easy access to the IPR services they need. This is particularly important for small firms, who experience geographical, cultural and language differences as major barriers to the use of the central, European patent authorities in Munich (Erhvervsredegørelsen, 1995 pp. 187, Patent- og Varemærkestyrelsen, 2000).

It is the overall aim of the government to try to make the intellectual property system more effective and economically affordable. This has resulted in a number of public initiatives. The government will try to improve the awareness of the intellectual property system and will also try to reduce the cost involved with patents especially the translations costs. Furthermore the government will try to ensure a more effective enforcement of the patents in both Denmark as well as EU. Among the initiatives considered are the establishment of an insurance system, which can help SMEs to enforce their patents.

3.5 Conclusions

The role of the Danish Patent and Trademark Office in the national system of innovation has so far been to offer protecting for inventions, trademarks, design and information services, guidance and training in the area of industrial property rights. Moreover, the DKPTO do preparation of legislation, develop policies within the field of IPR. However, the DKPTO might happen to fulfil a knowledge diffusing function as well, especially by way of the function of delivering services.

In this section we have drawn a broad picture of the role of the DKPTO in the Danish innovation system. We have described the various innovation-related activities of the DKPTO and the main relations with other actors in the innovation system.

The general conclusion is that the DKPTO external relationship includes a number of activities, which are supportive to patenting activities, and which are intended to support technological development. Furthermore the DKPTO is engaged in a number of activities, which entail "partnership" with other important actors in the Danish innovation system. Although the DKPTO, and patent institutions generally, are most often classified as regulatory institutions alongside legislation etc. (see figure 3.1) the interactions with other institutions and the role as "educating" staff competent in patenting who are subsequently being employed in industry, points to a possible diffusion role as well.

One such relationship is the contact with patent agents, which showed that they are at the same time partners, customers and competitors. As a governmental body it is important to the DKPTO to have clear division of labour to private organisations. As a consequence, a "common understanding of competition" has been established. Another relationship is the political system. The discussion showed that the IPR-area is also a high priority with the government. Also it was pointed out to that

the government had urged the DKPTO to improve external relations, especially to Authorised Technological Institutes.

However, the central question of this study is whether some of these activities are interdependent in any way. In particular the question is whether activities relating to business services, guidance of applicants, educational, and knowledge diffusion depend on the competencies attained by the DKPTO staff through search and examination activities. This question is explored in the following chapter below concerning the internal relations and competencies of the DKPTO.

4. Internal relations: linking internal processes and external activities[36].

4.1. Introduction.

Following the discussion of various relationships (i.e., the role of the DKPTO in the Danish innovation system) we now turn to the question of how this role is fulfilled. What are the basic *internal* prerequisites for the DKPTO to play this role? A broad perspective is hereby introduced, that focus is on the processes and resources that support and maintain activities. Business services are especially interesting in this connection as they may depend on the competencies and knowledge involved in (and acquired via) the handling of patent applications

However, the competencies of the patent department may be said to benefit other activities of the DKPTO such as business services, if knowledge indeed is diffused across departments. If so, they are important for maintaining the present role of the DKPTO in the innovation system. So it may be assumed that even if the process of handling patent application does not directly influence the level of innovation (and the local availability of this particular service therefore seems redundant) the competencies involved may still be required at a local, perhaps even intra-organisational, level.

In the following we will provide a general description of the main organisational routines and individual knowledge applied to the DKPTO's activities. The next step will be to link the knowledge and resources obtained by handling patent applications to some of the main business services, which have already been mentioned in the preceding sections. This is a question of what kinds of competencies are obtained through search and examination. In particular, the question is how these competencies come into play through internal processes of knowledge diffusion?

4.2. Knowledge and resources of the DKPTO

In the "Knowledge Account 2000" (which is a supplement to the conventional account, but focused upon the knowledge base of the DKPTO), the internal resources of the DKPTO have been divided into "human" and "structural" capital. To some extent, this distinction fits well with the tacit (non-codified) vs. explicit (codified) distinction employed in the theoretical discussion of organisational learning and cross-departmental knowledge flows in section 2.5.

Generally speaking, human capital consists of the skills, knowledge, and competencies of individual employees. Structural capital on the other hand consists of the knowledge and experience, which is "embedded" in the organisational structures, formalised processes, information technology, and formalised communication systems of the DKPTO. In other words, structural capital is the knowledge that stays with the DKPTO when individual employees leave.

[36] Substantial parts of this chapter have been written with the help of written inputs from Ph.D Ole Kirkelund of Dkpto.

While human capital consists of both tacit (non-codified) and explicit (codified) knowledge, structural capital is, according to the definition employed in DKPTO (2000), exclusively of codified knowledge such as patent literature, database information, and handbooks (guiding internal production processes). Thus, the human / structural capital distinction is more or less consistent with the tacit / explicit knowledge distinction.

The structural capital (explicit / codified knowledge) of the DKPTO consists of two main elements, according to the DKPTO's Knowledge Account 2000, i.e. structurally embedded knowledge and working processes. Working processes may be seen as a catalyst for knowledge diffusion as they may serve to diffuse both tacit and explicit knowledge. Furthermore, working processes themselves may be both codified and non-codified. Structurally embedded knowledge, on the other hand, is quite tangible. The most important resources include the following:

- Collections of handbooks containing technical and juridical literature as well as other relevant subjects.
- A collection of more than 30 mill patent documents.
- Internal handbooks on patents (and utility models, trademarks, design, and personnel).
- Internal checklists, guidelines, reports, and databases.
- Library resources including electronic journals and works of reference.
- Intranet.

These resources are physically quite tangible and they contain explicit and codified knowledge (in writing). The Intranet, in particular, also facilitates knowledge flows directly since it is the DKPTO's internal network for electronic communication. It is a very important medium for internal communication and it is the main pillar of the DKPTO's electronic casework system. News and information concerning internal working groups, projects, and initiatives are made available through the Intranet, which evolving technology is constantly being improved in order to support electronic casework. Thereby it supports the internal knowledge flows between individual caseworkers and between different sections of the DKPTO.

The human capital of the DKPTO consists (as mentioned above) of the skills, knowledge, and competencies of individual employees. The education of individual staff members and the internal training processes by which human capital is developed and maintained are important prerequisites for maintaining and enhancing the ability of employees to carry out their tasks.

Human capital is the key resource for fulfilling goals and strategies and for performing concrete activities. There are 31 "qualification profiles" have been developed in order to define the competencies required for different job categories. The qualification profiles stipulate four different kinds of qualifications / competencies (knowledge, skills, values, and behaviour).

These competencies constitute the basic elements of the human capital required in order to enable the DKPTO to perform its main functions and to fulfil its goals of playing a role in the innovation

system. In order to preserve and increase human capital and to strengthen competencies these goals have been linked with employee policies, wage policies, and action plans.

Knowledge sharing by developing working culture and daily routines is a key to preserve and developing competencies, which support the diffusion of especially tacit (non-codified) knowledge. Regular section meetings and workshops support this type of knowledge sharing besides ordinary educational programmes.

Some key figures concerning the personnel give a general impression of the DKPTO's human capital.

Table 4.1. Number of man-years by staff category in 2000.

Executives and heads of section	Consultants	Engineers	Other academic staff	Office workers and other staff
22,5 (number) 8,1 %	23,8 (number) 8,5 %	56,4 (number) 20,2 %	35,5 (number) 12,7 %	139,3 (number) 50,5 %

Source: Knowledge Account 2000.

Another key factor in evaluating the human capital of the DKPTO is the revenue of personnel (Table 4.2). The data would perhaps render a more correct picture in case it was divided into groups of personnel or weighted by the number of years of the DKPTO employment (there is a tendency of higher resignation rates among the younger employees). The data does, though indicate a preservation and build up of experience within the organisation. Resignations have been relatively stable at a level of 10-12 % of the total staff number (1997 – 2000). The increase in revenue in 2000 was largely due to a real increase in employment.

Table. 4.2. Revenue of personnel (absolute no. of persons) by staff category.

Employments	1997	1998	1999	2000
Engineers	9	14	4 a)	16
Other AC staff	10	11	9	16
Office workers	27	12	23	35
Total	46	37	36	67
Resignations	1997	1998	1999	2000
Engineers	5	15	5	7
Other AC staff	8	9	7	5
Office workers	10	9	12	22
Total	23	33	27	34

Source: Knowledge Account 2000.
a) Including one technical examiner.

A high revenue of staff is very expensive in terms of education and development of central competencies. The human capital of the DKPTO (especially concerning core activities in the patent area) is highly influenced by the revenue of staff. Accordingly, this has a bearing on the educational activities, necessary for maintaining the core competencies of the organisation.

The educational activities of the DKPTO are also very important to the internal diffusion of knowledge as teaching of new employees by experienced colleagues is an important part of the educational programme of patent examiners / engineers. Table. 4.3 shows the resources (measured by working days) allocated to different types of educational activities.

Table. 4.3 Competence development and educational activities in 2000.

Activity	Number of days	External / Internal
Basic training / patent course.	445	Internal
Training by experienced colleagues.	864	Internal
Advanced training of specialist incl. on-line search.	284	Internal / external
Basic juridical training and competencies.	210	Internal
Sales and marketing competencies.	35	Internal
Management training.	193	Internal / external
Networking competencies.	30	External
Professional and personal development.	495	Internal / external
Behavioural and attitudinal development.	396	Internal
Language proficiency.	230	Internal / external
Presentation and supervision techniques.	77	Internal
Presentation in writing.	28	Internal
Introductory meeting	57	Internal
Total	3345	-

Source: Knowledge Account 2000.

The activities that are relevant in connection with the central functions of the DKPTO (patent case-work) take up a large part of total educational and competence building activities. The activities basic training, training by colleagues, and advanced training of specialists, totalled a number of 1593 working days. It is a central characteristic of these activities that they occur internally within the DKPTO.

When the DKPTO take on new employees (engineers and natural sciences candidates) a comprehensive educational programme is implemented in order to train new employees to become competent patent engineers. The training consists of a "two-step-training" programme. The first step is the basic training course, by which the employee obtains the so-called "announcement right". The second step by which the employee is appointed "patent engineer" requires additional training and experience (in particular training by experienced colleagues). The basic training programme consists of both theoretical and practical modules, which are necessary in order to obtain the basic competencies for handling patent applications. The duration of the course varies depending on the specific needs of the employees and developments in the field of patent technique. The training by experienced colleagues has a duration of about 1 – 1 ½ years. It has character of apprentice learning, and is combined with specialised competence building and training on specific technical issues. This additional training could, e.g. include international courses in patent technique under the Centre d'Etudes Internationales de la Propriété Industrielle (CEIPI). In addition to the specific technical skills, the apprentice learning also involves substantial transfer of tacit knowledge. In total it takes about 3 years of training before new employees can be appointed "patent engineers".

It is quite expensive to educate new employees to the level of "patent engineer". Total cost costs for each patent engineer is over kr. 900.000. Table 4.4 shows the level of competencies, which were obtained in the period of 1998 – 2000.

Table 4.4 Levels of competencies of technical caseworkers.

Level of competence	1998	1999	2000
Trainee	12	6	14

Announcement right	9	10	15
Patent engineer	3	6	6
Patent specialist	27	28	21
Consultant	9	5	8
Total	60	55	64

Source: Knowledge Account 2000.

It appears that although the DKPTO had 12 trainees in 1998 this has not resulted in an increase in announcement rights in 1999. Although it is not possible (based on the numbers of table 4.4) to determine how many of the trainees have stayed within the organisation, the total number of technical caseworkers dropped from 60 in 1998 to 55 in 1999. (The total number of technical specialists increased to 64 in 2000).

Regardless of the actual revenue of technical caseworkers, those numbers comprise the central human capital employed in maintaining the core activities of the DKPTO regarding patenting. The handling of patent applications is beyond comparison the most important activity of the DKPTO. Other activities (in particular business services) comprise only a very small part of the activities in terms of economic revenue.

With this in mind, we proceed to discuss how the technical competencies might come into play in the production of business services.

4.3. Linking activities, human, and structural capital.

In this section we discuss how human and structural capital are linked to the activities of the DKPTO. Focus is on business services and the possible linkages to the (technical) knowledge and competencies associated with the handling of patent applications.

As indicated in the previous section, the activities related to patenting can be divided into two main groups. First, there are activities directly related to patenting, i.e. the casework involved in handling patent applications. Second, there are business services, which may influence the IPR strategies of companies.

While the linkages between activities and human and structural capital may be fairly obvious, (patent engineers trained in patent casework are required), the linkages between business services and human and structural capital are not quite as obvious. In order to shed light on this, a short description of the most important business services is useful. Subsequently, in section 4.4 we describe the procedures in granting a patent.

The descriptions provided here do not cover all kinds of business services. Only those that are seen as the most important to innovation activities of companies and inventors are included in the analysis. The review is based on the descriptions of individual services in the DKPTO's "Handbook of Products". The production processes connected to the services are also briefly described in the handbook and further information has been gathered through interviews with employees in S&M and in the patent section.

Central business services:

Novelty searches:
This service is intended to establish whether an invention is "new," which is important in terms of patentability. Novelty searches are, therefore, an important element of the casework involved in handling patent applications. However, novelty searches can also be delivered as a "stand-alone service" on different scales. Customers can obtain a "limited search" which may be limited as regards temporal coverage and / or geographical scope. A "full search", on the other hand, is equivalent to novelty searches carried out in connection with a standard patent application. Alternatively, customers may request an exploratory search, which is basically a simple search in IPC-classes and technical terms.

Novelty searches are carried out by investigating relevant international patent literature either manually or by searching databases. This is done on the basis of the customer's descriptions or drawings of the invention. Occasionally, this type of communication is supplemented by telephone conversations with the applicant concerning the scope of the search and how to understand the task, which has been given. The results of the search are compiled in a report covering the following main issues:

- A clear description of the problem.
- A summary of known technique that is relevant vis-à-vis the invention.
- An overview of provided material sorted according to the categories "especially relevant", "state of the art technique", and "general information".
- A description of the scope of the search.
- An account of the material included in the investigation (e.g., in the form of a specified "novelty search report").

This service may quickly offer customers a preliminary indication concerning the possible patentability of an invention and facilitate partnerships or financing. As such, a novelty search may guide customers in making decisions concerning investment and further research and development of a product.

On the other hand, these stand-alone novelty searches are usually not complete and it does not include a patentability assessment. Careful assessment on the part of the customer is therefore required in order to exploit the novelty search properly.

Novelty searches require knowledge of the specific technological area in question and of analysing it in terms of terminology and principles of operation. Juridical patent knowledge concerning novelty, patentability, infringement, and national / international patent systems is also required for novelty searches.

Infringement inquiries:
This service investigates whether a customer's product violates the IPRs of another company or person if marketed. The inquiry may be limited to material provided by the customer, but apart from this, infringement inquiries involves more or less the same search operations in patent literature and databases as is the case with novelty searches. However, infringement inquiries on certain points go a step further than a novelty searches. Although it contains more or less the same elements, infringement inquiries are nevertheless somewhat more complicated. The most important difference

pertains to the level of analysis required. Found material is commented, which is usually not the case with novelty searches.

The question of infringement is, furthermore, an important element in establishing patentability, which requires a closer assessment of the technical properties of the product in question than is required in novelty searches.

Besides offering a more thorough assessment of the technical properties of the customers' product, which is relevant for deciding to apply for a patent, infringement inquiries offer more or less the same advantages as novelty searches. Thus, it may guide decisions on further investments and development. In particular, it may guide decisions on whether or not to market a product.

As is the case with novelty searches, careful assessment of the results of the investigation is still required on the part of the customer, since infringement inquiries do not fully establish the exact risk of infringements.

State of the art technology inquiries:
Inquiries into state of the art within a specific technology area are equally based on searches in international patent literature both manually and in electronic databases. Searches into other relevant material are provided on the customer's request.

The purpose of this type of inquiry is to give inspiration to customers for further development of a product. It is somewhat broader in scope than a novelty search as the focus is on technology assessment of a technical area in general rather than on the customer's own product as in novelty searches and infringement inquiries.

A state of the art inquiry may be especially useful in deciding to launch a development project (i.e. before a concrete product has been made or even conceived). State of the art inquiries are often followed up by monitoring of technical areas.

Profile analyses:
The services mentioned above are quite technical in nature as they aimed at assessing technology, e.g. according to novelty or potential infringement of IPRs. Profile analyses can be both technical and non-technical depending on the type of profile in question. The DKPTO offers basically four different types of profiles, industry profiles, company profiles, product profiles, and technique profiles.

Of these, product profiles, technique profiles, and (perhaps to a lesser degree) company profiles are especially relevant for research and development and IPR strategies of individual companies and inventors. A company profile describes one or more specific companies as requested by the customer (typically competitors of the customer). The competitors are analysed in terms of IPR activities and market position. Assessments of the level of technological development of the company in question may also be included in the analysis. Product profiles investigates to what extent a certain product is covered by IPRs. In particular, the analysis uncovers which companies are active in terms of IPR protection, geographical localisation of rights, and what parts of the product are protected. Technique profiles describe a specific technical area and compile the results of the analysis in genuine literature report (including patents, utility models, and designs). Focus is on state of the art of technology and the latest trends of technology development.

Monitoring ("overvågninger"):
Monitoring consist of searches that are repeated periodically. This type of searches can be aimed at different types of information depending on the needs of the customer. The main types of monitoring include:

- Monitoring of a specific technical subject through patent literature or relevant technical literature.
- Monitoring of the activities of certain companies or inventors concerning patenting (or utility models, design, and trademarks).
- Monitoring of activities concerning a certain IPR identification number ("rettighedsnummer").
- Monitoring of changes in intellectual property law within a certain (e.g., technical) area specified by the customer.

The results of the monitoring are also provided in the form of a report similar to those provided in connection with other business services, i.e. an account of the problem to be solved, the information uncovered via the search, and an analysis of the information.

Evidently, the different types of business services have a number of common elements. The type of information involved is often more or less the same, i.e. the same patent literature and electronic databases are employed. The differences lie mainly with the way the information is processed and analysed.

Most of the business services that are mentioned above require technical as well as juridical knowledge on the part of the DKPTO's employees (and on the part of the customers in order to be able to utilise the information). The question is how, exactly, does the competencies within the DKPTO come into play in the "production processes" of the business services? Are they in some way linked to the competencies associated with (and acquired through) the handling of patent applications?

Organisation and production processes:

Codified, internal production processes indicate a rather loosely integrated production process, which is not backed up by informal / non-codified working processes. However, the production of technical business services is substantially closely linked to and dependent on expertise on searching and assessing the international patent literature. By way of organisation, although the business services are sold through the sales and marketing section, they are produced in the patent section.

Interviews with employees of the S&M and the Patent sections have indicated a relatively clear division of labour between the two sections concerning the production of business services. Thus, the internal diffusion of knowledge that is required for the production of business services does not differ much from the codified processes as described in the internal handbooks and production guides.

According to the internal production guides, the organisation of production processes concerning the services mentioned above is broadly speaking the same. There are only small differences be-

tween, on the one hand, technical services (novelty searches, infringement inquiries, and state of the art inquiries) and, on the other hand, interdisciplinary services (profile analyses and monitoring).

Production guide of technical services:
The production process for technical services can be described as a 6-step process involving mainly two individual employees (one in the S&M section and one in the Patent section). The 6 steps are described below.

Table. 4.5. Production guide of technical services.

Step	Task	Who	Timetable
1	Selling of the service	S&M, sales representative	
2	The case is filed and handed over to the responsible person in the patent section	Patent section, responsible caseworker (invoice and deliverance to the customer)	Day 1
3	The customer is contacted and technical details and the specific purpose of the job is established	Patent section, problem solver i.e. a technical expert / patent engineer	Day 1
4	The job is carried out and the results are filed in a report	Patent section, problem solver (i.e. technical expert / patent engineer)	Day 2 – 9
5	The report, cover note, and invoice are submitted	Patent section, responsible caseworker	Day 9 – 10
6	Follow-up and feed back from the customer	Patent section, responsible caseworker	Day 20

Source: DKPTO, Product and Service Handbook. (2000).

As illustrated by the table above, the initial contact is established through the S&M section. The main task of this section is to sell business services to customers when it is considered important to the customers. This is based on the assessment of the sales representative and on the experience with regular customers. Knowledge concerning the business services is of course also diffused through general information in folders, articles, courses, and the Internet. Customers may therefore also make contact with the DKPTO on their own initiative.

The S&M section is the customer's gateway to business services and the S&M section is responsible for the initial communication to the Patent section of the customer's request. Thus the S&M prepares the case, which is thereafter taken over by the relevant employees in the Patent section. This is initially an employee who is assigned as responsible for the specific case. The case is then handed over to a technical expert / patent engineer. The responsible caseworker and the problem solver / patent engineer is often one and the same person. Alternatively, the job is handed over to the head of section who then hands over the job to a patent engineer of his / her choice. (according to interviews).

After these steps the substantial problem solving (search and technical investigations) begins. Whether the service in question is a novelty search, infringement inquiry, or state-of-the-art-inquiry it requires more or less the same competencies and knowledge as required for search and examination of patent applications. (See section 4.4 on patent application procedures). Therefore, the patent engineer also takes care of further communication with the customer, which is often of a technical nature. After the report has been completed, the patent engineer hands it over to the responsible colleague who hands over the report to the customer with a cover note and an invoice. He or she also takes care of further communication with the customer.

Production guide of interdisciplinary services:
Monitoring and profile analyses are categorised as interdisciplinary as they typically entail several elements of other types of services and are often iterative. They entail a 7-step production process if you include the possibility of periodical repetition and the division of labour in producing this type of service is more or less the same as for technical services.

The production guide of profile analyses entails the same division of labour as the other services. However, the internal production guide in the DKPTO's Product and Service Handbook does not distinguish between the responsible caseworker and the problem solver. Furthermore, the production of profile analyses is characterised by the fact that several employees co-operate on solving the same task.

Table. 4.6 Production guide of profile analyses.

Step	Task	Who	Timetable (hours)
1	Co-ordination	Sales representative / problem solver (patent engineer)	2
2	Search in patent databases	Problem solver (a)	2
3	Search of literature (internal books of reference + Internet) processing of data	Problem solver (a) / librarian	4
4	Statistical and graphical processing of search data	Problem solver (b)	2
5	Evaluation of the latest patents and their technical properties	Problem solver (a)	4
6	Additional database search if necessary	?	4
7	Compiling of data and writing of report	Problem solver (a)	20

Source: DKPTO, Product and Service Handbook. (2000).

As the table above indicates, the production of profile analyses apparently involves more people than most of the other business services. Profile analyses are custom-made, and do not á priori contain any specific element. It is, therefore, important that the S&M and the Patent section co-operate already at the initial stages of the production process. Hereby the exact content of the job and the specific needs of the customer are established. This is important for planning and organising the production process.

4.4. Procedures in granting a patent[37]

This section describes the main elements of the casework involved in the process of granting patents. The processes that are described in the following also constitute the main prerequisites for building competencies and generating knowledge via patenting.

Before a patent can be granted, a claimed invention must undergo a number of "tests," in which the examiner evaluates whether or not the invention is "new" (global novelty), represents an "inventive

[37] This section is largely identical to the description of search and examination processes in the DKPTO as presented in PA Consulting Group: "Quality Assurance of Search and Examination in the European Patent System". (20 May 2001). It was originally drafted by Dkpto and subsequently included in the just mentioned report.

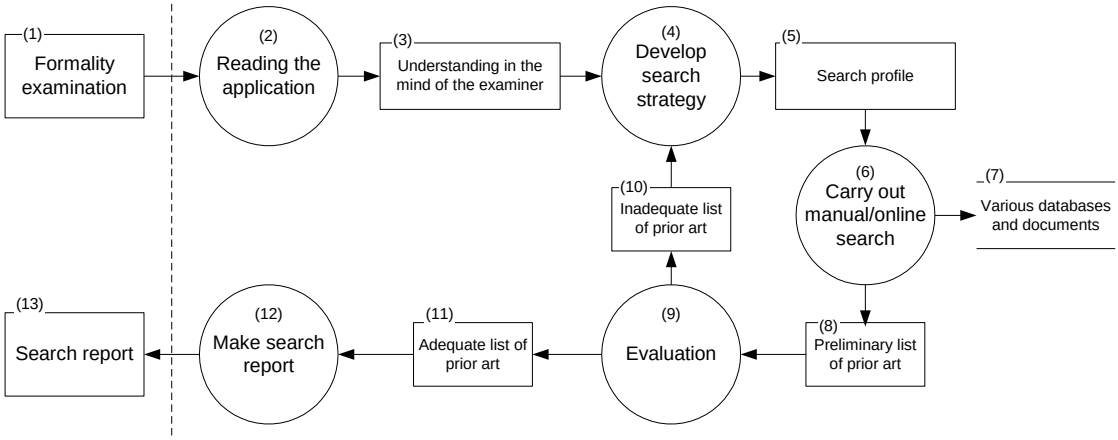
step" as compared to state of the art technique (prior art), and can be commercially exploited. The answer to all three tests must be in the affirmative.

The casework involved in examining a patent application also include evaluation of "formalities" i.e. questions concerning payment of fees, deadlines, information concerning the applicant or the authorised attorney. However, these questions are of a legal nature and do not involve the technical knowledge and competencies required for search and examination.

In the context of building competencies and (at least potentially) promoting innovation via the process of patenting, search and examination are the central parts of the casework (indicated by the broken line in fig. 4.1). Thus, the main elements of patent casework are novelty search and substantial examination.

Fig. 4.1 describes the main elements of the search process. The figure explains (or at least indicates) where the knowledge and competencies of examiners come into play. The purpose of the search is to establish any so called "prior art," which is relevant for determining novelty and the inventive step of the invention.

Figure 4.1 The search process



The main elements of a search process are shown in figure 4.1, which will be explained in more detail below by reference to the numbers of each element.

1. After filing, the application is checked for various formal requirements before it will proceed to search. The application is given a preliminary IPC-classification in order to assign an examiner to the further casework.

2. The examiner reads the application in order to understand it from a technical point of view.

3. Before the examiner can carry out a search, he must have a clear understanding of the invention from the point of view of patentability. He considers the prior art already mentioned by the applicant in the application and any other prior art he may know from experience. Furthermore, he considers any difference between the invention and the prior art, and finally he tries to establish

the technical effect, which the invention achieves over prior art due to the specific new features of the invention.

4. This basic understanding of the invention allows the examiner to define the subject and the scope of the search and to set a strategy for how he will search.

   The examiner decides on the relevant class(es), group(s) and subgroup(s) of the classification systems as well as suitable search terms.

   Based on his experience, the examiner considers how he should carry out the search in the most efficient way. He may start by a manual search, or he may start by an on-line search. He will also have to decide (particularly in the case of manual searches) the order in which he will search classes and countries. And he may even decide to restrict his search, if search reports from other authorities are already available. Precedence is given to the units in which the probability of finding relevant documents is highest.

5. The selected classification units and search terms comprise a search profile.

6. The examiner then carries out the search, directing his attention to novelty, inventive step and technological background of all or the significant patent claims.

7. The search is carried out electronically in patent databases (EPOQUE), other databases, e.g. journals and/or as a manual search in patent documents.

8. As a result of the search, the examiner ends up with a preliminary list of prior art.

9. The examiner evaluates the result of his search. The primary purpose is to get a preliminary impression of the relevance of the retrieved documents and to limit the number of documents to a manageable size.

   The examiner may decide to stop the search if documents have been found that clearly demonstrate lack of novelty of the claimed invention or he believes that the probability of finding further relevant documents is very limited. It is very much up to his experience to exercise this discretion.

10. If the examiner believes that further search will result in better prior art, and the list of prior art therefore is inadequate, he reconsiders his search strategy and makes another search based on an improved search profile (4).

11. If the examiner is satisfied with the list of prior art the list is adequate.

12. If the list is adequate, the examiner goes on to draft the search report.

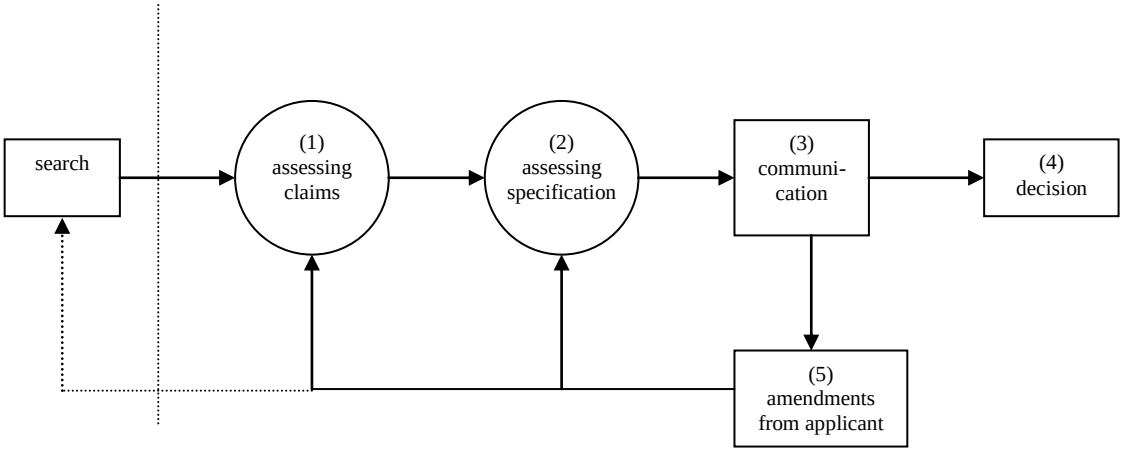
13. The search report contains a shortlist of the relevant prior art rated according to pertinence. Category X is prior art, which is considered damaging to novelty and inventive step of one or more claims. Category Y is prior art which taken in combination with other prior art is damaging to inventive step. Category A is prior art, which will not damage novelty or inventive step, but shows the state of the art closest to the invention.

The search report also states, with reference to specific claims of the application, the examiner's reasons for citing a particular piece of prior art. Furthermore, the search report specifies the main features of the search profile (classes, countries whose documentation has been searched, databases etc).

The purpose of the substantive examination is to arrive at a conclusion on granting a patent or refusing the patent application. During this process the claims and the patent specification may be amended (within certain limits) in order to meet the requirements for granting of the patent.

The products of the examination are one or more communications to the applicant, concluding with a final decision (which can be appealed).

Figure 4.2



The main elements of the examination procedure are shown in figure 4.2 and will be explained below with reference to the numbers in the figure.

1. The examiner starts by scrutinising the application and the prior art in order to arrive at a well-founded opinion of the patentability of the invention as claimed by the applicant. This includes issues like novelty, inventive step, unity of invention, support of the claimed scope, clarity.

2. The patent specification is checked for a number of requirements like the explanation of the invention (relevant prior art and the technical effect over prior art), support of the scope of the claims, clarity, mentioning of all independent claims, etc.

   Assessment of the claims and the specification will in many cases be carried out concurrently since they to some extent are interacting.

3. Based on the assessment, the examiner will draft a communication to the applicant. In rare cases this will be an acceptance for grant. In most cases, however, there are one or more objections, which will then be communicated, usually with some guidance as how to amend the application

properly. The objections may range from more serious issues like lack of novelty or inventive step to more simple issues like a need for clarification. All objections must be reasoned and if necessary refer to specific articles or rules.

4. The first communication may, as mentioned, in rare cases be an immediate acceptance of the application. A decision of refusal of the application may not be issued until the applicant has been given the opportunity to present his observations.

5. The applicant will be given a time limit to reply to the communication. Within this time limit the applicant must amend or at least argue against the objection of the examiner. He will therefore carefully assess the communication.

The examiner assesses the claims and/or the specification again and decides whether the amendments are "allowable" (i.e. concur with the original application/invention) and whether his earlier objections are complied with.

If the search is still valid, the examiner assesses the claims and/or the specification again and decides whether the amendments are allowable and whether his earlier objections are compiled with.

The examiners then draft a second communication. It is the general objective of the DKPTO that the second (or the third at the latest) communication must be a final decision. In exceptional cases, even allowable amendments may change the focus of the invention to such a degree that the examiner finds it necessary to make a complementary search.

4.5. Conclusions.

In the preceding sections the external and internal relations of the DKPTO have been discussed. External relations give a first impression of the possible role of the DKPTO in the innovation system. Describing external relations is basically a question of linking central activities and actors.

The general conclusion concerning internal processes is that the interdependence between the competencies acquired through patent casework and those required for technical business services is not based on the formal (codified) or informal (non-codified) organisation of production processes. Rather it is a substantial interdependence, i.e. it is based on the nature of services in question. In other words, interdependence between competencies would still prevail, even if the S&M section did not exist. Vice versa, it follows from the above-mentioned view that the S&M-section could service industry with enhancing general awareness of IPR and sales of business services without having the technical expertise, as represented by the patent section, in-house. In principle, the technical search and examination processes could be bought from outside the organisation (or even outside the nation) and re-sold through the S&M-organisation/department. However, a number of practical difficulties are associated with this idea. In particular, the possibility of comunicating directly (in Danish) with the responsible patent examiner would most likely be limited or non-existent. This would delimit the potential value of the services in question.

Interviews in the S&M and Patent sections have indicated that the functionally separated working processes are characterised by codified, internal structures of knowledge diffusion while potential non-codified (informal) ones seem rather limited. Actual case-by-case co-operation between the sections is rather limited. Although most business services (in particular technical services) are produced with a quite clear division of labour, there is probably more room for non-codified co-

operation internally within each section than between sections. One could therefore argue that the specific internal relations and the diffusion of knowledge between the S&M section and the Patent section is in fact not very developed, but perhaps that is not necessary. The latter depends on the organisation of the patent system and the role a national institution may play in this. Even if this is a big research project in its own, and beyond the scope of the present research, it is touched upon in chapter 7.

5. Mutual competence building – cases from Danish enterprises[38]

5.1. Introduction

Chapter 2 pointed to some of the possible ways of competence building of relevance for innovation. Chapter four highlighted more precisely where in the patent granting process such learning processes are likely to take place. This section sets out to illustrate, via descriptions of three real world cases, if some of the theoretical considerations are indeed also to be found in practise. As the primary purpose with the chapter is to explore in more detail the nature of the learning processes and learning effects of the interaction between DKPTO and the firms, the cases are not chosen randomly. On the contrary they are picked under the presumption that they are exactly illustrative of the desired of learning processes we are looking for. In the next chapter, we look at whether these possible effects are likely to be more wide spread.

This chapter starts out with a short discussion on research strategy and methodology. The cases are structured as a first presentation of the applicant firm, its' industry, its' technological competencies, patents. Secondly, we show what is the interaction between the firm and PVS. Thirdly, learning effects are identified and possible implications for the firm are discussed. Finally, the ramifications for the quantitative study are reviewed.

The presentation of the interview is first and foremost a reproduction of the interviews, which are transcribed into stories. We have chosen to include only the relevant perspectives that were discussed in the interviews.

To avoid misunderstanding of the transcription of the interviews, the respondents afterwards passed remarks on the case stories. The stories are supported by quoted statements. Each case story is presented individually and subsequently the stories are linked together and the common denominators are emphasized.

5.2.The research strategy chosen

The overall purpose of this report is to investigate whether industrial innovation in Denmark benefits from having a national patent office. We have chosen to examine this topic by carrying out a *survey* and a *case study*. The two methods are complementary and they allow us to answer different sets of questions, which would not have been possible if just one method were used[39]. The survey gives us answers to who, what, where, how many, and how much questions, and the case study gives us the answers to how and why questions[40].

[38] The main author of this chapter is research assistant Mia B. Rasmussen.

[39] Likewise a case study can be used for development of the right questions for a survey and data collected from surveys can be used in case studies (Yin, 1994).

[40] Case studies are appropriate when how and why questions are asked and where focus is on contemporary events and when there is no control over the behavior of the sample (Yin, 1994: pp 3-15).

The case study is used for examination of relations and the interaction between the DKPTO and its' customers and so the case study gives us the answers to how the DKPTO is used and why the DKPTO's customers use the national patent office. Qualitative interviews have been used for collecting data for the case study. In general the qualitative interviews are useful for illustrating perspectives from inside, show opinion coherence, give complete description, formulation of hypotheses and theory (Buciek K., 1996 pp 15-23).

The case study allows us to show ways of using the national patent office and to illustrate how the national patent system can be utilized in the best possible way. We get a chance to see what is going on in the interaction between the DKPTO and its users and to illustrate which of the learning processes mentioned in chapter 2 is in use between the two players. The conclusions can of course not be used for making generalizations, as the sample is not representative.

The case study includes four case stories first and foremost based on interviews with an employee or manager engaged in the company's patent policy. The case study includes the case stories Rockwool, Østjysk Innovation and the Technological Institute and Pure Snack, Plougman & Vingtoft and Patentgruppen, and Kristoffer Larsen Innovation A/S. Each company was carefully selected in the hope that we can show different ways of using and interacting with the DKPTO. The companies selected are also very different. They differ in size, product, incentive for using the patent system etc. Kristoffer Larsen is for instance a one-man company and he just recently started to use the patent system. Rockwool on the other hand is one of the largest companies in Denmark and have taken out many patents for years and today they have a number of employees who are dealing with patents only. It is obvious that these companies use the national patent office in different ways and hopefully our cases stories will illustrate this variation. Employees of the DKPTO marketing department helped us select the cases according to our criteria.

The case study includes a description of the individual case companies and the industries in which they operate. The industry descriptions seek to point out the level of importance of having patents in the particular industry. As mentioned before for some companies, in certain industries, the patent portfolio serves as a very important competitive asset whereas other companies choose strategies such as lead-time and secrecy instead of patents to get or stay ahead of competitors. The chosen strategy will typically be determined by conditions such as how easy it is to imitate the product, how easy it is to get around the patent, the industries traditions for taking out patents etc.

To get a better understanding on the procedures of patent applications, the business services offered, and the patent examiners relations to customers, we used earlier reports (consumer analyses, descriptions of procedures for patent application and others), the DKPTO homepage and the DKPTO Intranet. The information gathered was used for formulating the right questions for both the case study and the survey. Besides the material found we also held several informal interviews with employees of the marketing department of the DKPTO and patent examiners in order to get the right understanding of the patent system and how it works. The informal talks with the different employees of the DKPTO were crucial for formulating the right questions for both the survey and the case study[41].

[41] One of the researchers involved in this present review had the daily work place physically at DKPTO in about half of the research time (½ year). This greatly benefited the researchers assessments of the internal organisation of DKPTO and of the way DKPTO operates in relation to external parties.

5.3 The data used in the case study

Due to the fact that it was not possible to find existing information on companies and institutions way of using and interacting with DKPTO, it was necessary to collect our own data. For this purpose we used qualitative interviews.

There are a number of different types of qualitative interviews, which are suitable under different circumstances. The interviews can be divided into the intensive[42] and the extensive interviews (Buicke, pp 15-23). Normally the intensive interviews are used when you are examining people's way of living, their attitudes, basic values etc. It is a precondition when conducting such intensive interviews that the interviewee is close to the respondent physically and mentally. The other approach to the intensive interviews is called the extensive interview. This method is typically used when you are after facts and for instant need to give complete description of processes etc. The extensive interviews are suitable when interviewing key persons such as managers and experts who have important information. The extensive interview is also less time consuming in comparison to the intensive interviews.

For our case study we used the extensive interview method and the respondents were considered an informant or replacement observer on the topics how to use the DKPTO, how to communicate and interact with the DKPTO, whether the interaction or just existence of the national patent office has influenced the companies innovations activities. In our extensive interviews it was the respondents personal observations, which were of interest. In the intensive interviews the focus was on at personal attitudes. Personal statement and attitudes were, however, mentioned during the interviews but it was not the important element in the interview.

We used a semi-structured[43] interview guide for each interview. The guides contained basically the same questions and only small adjustments were required for each interview. The interview guides were sent to each respondents a few days before the interview, so the respondents had a chance to look through the questions and be prepared for the interview.

The interviews lasted between 1½-2 hours and each interview was introduced with the respondent talking about his or hers company. During the interview, the questions were read aloud and the respondent answered. The questions were open-ended and a large part of questions requested the respondent to come up with examples. We choose this technique to ensure that the respondents answered thoroughly.

[42] Buick divide the intensive interviews into the following categories the life style interview, the biographical interview, the theme interview, the group interview and the therapeutically interview.

[43] Semi structured interviews are less formal than the structured interview. When using this particular approach you use the broad topic area of interest to construct questions, which are asked during the interview stage of the project. The schedule will often use open-ended questions which are not uniformly worded and which are designed to probe beyond the standardized responses to gain more information regarding the research area (www.jura1.eee.ac.uk).

5.4 Case: Kristoffer Larsen Innovation A/S[44]

Kristoffer Larsen Innovation A/S is a one-man business. The company sells imported spare parts for trucks and it has been Kristoffer Larsen Innovation's main source of income the past 15 years. During the past teen years the owner has also been busy inventing equipment for the production of pork. Today Kristoffer Larsen Innovation A/S has invented a house for free-range pigs and an advanced feeding robot, which ensure that each pig automatically receives precise individual feeding[45]. The robot thus identifies the pig, its weight and individual feeding need. By doing so it becomes possible to trace back in time what fodder each individual consumed. This allows you to investigate what are possible inexpedient effects of different types of fodder, medicines, environmental factors etc. Kristoffer Larsen Innovation A/S applied for patent on the ability of the robot to link each individual pig to thee record of consumed fodder. Kristoffer Larsen Innovation A/S is constantly involved in new invention activities. Currently, the owner is for instance working on an outdoor pig toilet.

5.4.2 The Danish Pork Industry

The industry and business environment in which each company operates will influence the motives for applying for patents. It has therefore been useful to begin each case story with a short description of the particular industry each company operates within and illustrate how it influences the company and its patent decisions.

There has been a steady increase in the actual pig population. Today more than 80% of the Danish pork is exported and it makes a total of almost 6% of the entire Danish export (Svinebaroner, Børsens Nyhedsmargasin feb. 1998).

The development of the industry has been characterised by strong concentration tendencies. In 1980 there were 68.929 pig farmers and in year 2000 the number was down to 15.985 (Danske Slagterier, 2001). At the same time a large part of the pigs are now produced at very large farms also known as pig factories[46]. So today, there are fewer pig farmers, though the farms have become larger. In addition, the industry has become more differentiated. Farmers has introduced new ways of production and changed the fodder. Examples of differentiated pork are organic pork and free-range pork[47].

Due to the limited domestic market, this can effect for free-range pork and organic pork is limited and this might of course restrict Kristoffer Larsen Innovation's sale opportunities of the equipment (huts, automatic feeding system etc.) in this specific segment. However, Kristoffer Larsen Innovation A/S's equipment can also be used for outdoor sows, a fairly new and popular way of holding

[44] Additional Interviews in this case:
Danske Slagterier, Friland Food, Torben Stensig

[45] At the time Kristoffer Larsen Innovation A/S let out two of the feed machines and he expects to increase the number to six this year.

[46] In 1980 1,5% of all pigs delivered to the slaughterhouse came from farmers with an annual porker delivery at 4000 or more. In year 2000 this number has increased to 41,7% and of this number 8,7% of the pigs came from farmers with an annual delivery at 10.000 or more.

[47] However, these alternative ways of producing pork still make up a small part of the entire pork production. The organic pork production make up 0,2% of the total pork production and free-range pork production make up 0,4%.

sows (Friland Food, 2001). Moreover, it may be used for conventional indoor production of pigs with pigs being free in the stable.

There are 40.000 outdoor sows in Denmark that is equal to 3,4% of the entire sow population. In 1996 the number was 1,9%. The regulation for outdoors animals determine to a large extend the number of outdoors pigs. Today the regulation includes claims for space needed for each sow. The space requirements were partly introduced because of animal friendly reasons and partly because of environmental concern. The regulation of animal welfare and the environmental concern and what is considered to be of greatest importance, will be crucial for the progress in the industry.

Just as the outdoor and organic pork production is regulated there is regulation pushing towards indoor production of pigs with pigs being free in the stable. This is both a domestic trend and an EU-trend. Therefore, both the regulation and the development in consumer preferences supports the development of the market for the feeding robot and –house.

5.4.3 Equipment for outdoor pigs

Today the number of outdoor pigs is relatively limited partly because of limited demand for free-range pigs. These circumstances are also reflected in the used production equipment for outdoor pigs. The equipment used is huts and fence and sometimes the farmers also use an automated feeding system. These feeding systems typically only ensure supply, and not exact measured distribution for each individual pig as Kristoffer Larsen Innovation A/S's system does. In general the equipment used for outdoor pigs is not especially automated in comparison to the equipment used in traditional pork production. One explanation could be that the farmers today hold a limited number of outdoor sows or free-range pigs and advanced technical production systems do not pay off.

Most of the inventors of equipment for outdoor pigs are farmers who are changing existing systems to ease the work with the pigs. The improvements of existing systems are often smaller adjustments so the equipment fits the farmers individual herd of pigs and the inventions are usually not very advanced. Often the farmers use individual solutions for production and they share their good ideas with other farmers.

Most of the work with new inventions is informal and rarely patents are applied. Today, Kristoffer Larsen Innovation A/S actually seems to be the only firm in Denmark who is applying for patents for equipment for outdoor pigs. Also, at the moment it makes no difference if you have patents on your equipment for outdoor pigs or not. The chances of your idea being imitated seem to be small and the possibilities of exploiting the patents are limited as well. However, it is likely that the situation will change. First of all because outdoor pigs is a fairly new phenomenon but also due to change in regulation and consumer preferences.

5.4.4 Kristoffer Larsen Innovation A/S 's contact to PVS[48]

Kristoffer Larsen Innovation A/S has been busy inventing equipment for pigs since the mid 90s and as the first inventions began to take form, he decided to apply for patents. Kristoffer Larsen Innovation A/S contacted the DKPTO in 1998 and set up a meeting. Among the participants at the meeting

[48] It should be made clear that the described interaction between Dkpto and the respondents in this and other cases, have not in any sense violated the agreement on code of conduct vis-à-vis private patent agents.

was the patent examiner Michael[49], who at that time dealt with patents within the agriculture area. Later Michael became Kristoffer Larsen Innovation A/S's permanent case officer. Kristoffer Larsen Innovation A/S presented the feeding robot at the meeting and the participants from the DKPTO first impression was that the idea was good. After the presentation, the meeting participants went to the library where a novelty search (a patent technical search) was conducted. No existing patents were found on the automatic feeding robot and the DKPTO requested Kristoffer Larsen Innovation A/S to go on with the patent, and to find a patent agent to help formulating a patent application. Kristoffer Larsen Innovation A/S chose one of the larger patent agents in Denmark, who helped Kristoffer Larsen Innovation A/S select the right patent strategy, including the formulation of the patent claims. To ensure that the patent application was optimised Kristoffer Larsen Innovation A/S included a third party, DKPTO, to make a patent family search. No infringements were found under the search and Kristoffer Larsen Innovation A/S became aware that the patent was too narrow. Kristoffer Larsen Innovation A/S decided to broaden the patent and so maximise his ability to exclude others. The patent application was reformulated, a new test was conducted and the application was finally accepted but no patent is yet issued.

Kristoffer Larsen Innovation A/S has now applied for three patents and none of them are yet finally approved. However, Kristoffer Larsen Innovation A/S's applications have passed the novelty search and the inventions are technical advanced. So it should probably be a matter of time before the patents are accepted. Today Kristoffer Larsen Innovation A/S's only intellectual property is a trademark.

Kristoffer Larsen Innovation A/S has first and foremost used the DKPTO to obtain intellectual rights, patents and trademarks. However, Kristoffer Larsen Innovation A/S has also as part of the patent application bought the services novelty search and patent family search in order to set up the right claims. The use of these investigations has made Kristoffer Larsen Innovation A/S aware of whether the patent application was optimised and contained the right claims. He estimates that he has spent roughly 150.000 kr. at the services patent family search and novelty search.

It is Kristoffer Larsen Innovation A/S's assessment that DKPTO services patent family search and novelty search could be bought from any patent agent. However, Kristoffer Larsen Innovation A/S has never considered using other suppliers than the DKPTO for such services, because he so far has been satisfied with their work.

".... If I had been unhappy with DKPTO's way of handling my case and if I did not have had good relations to my case officers, I might have used a patent agent for conducting the services, but so far it has not been necessary!"

Moreover, the patent on automatically linking individual pigs to its past consumption of fodder is technically advanced, and according to the respondent, it is highly uncertain if the process could have been carried through without the assisstance of the DKPTO. Kristoffer Larsen Innovation A/S has during the last years learned much on the patent system and how it works. His interaction with the DKPTO has especially increased his knowledge on how to apply for patents and Kristoffer Larsen Innovation A/S is today much better at making descriptions of the patent used by the agency. Also Kristoffer Larsen Innovation A/S has learned how to judge a patent and the patent claims, and he can easily see the possibilities in a patent.

[49] The name of the patent examiner is fictitious but the authors are aware of the real name.

"...I have increased my knowledge of the patent application and gained a better insight in the patent system. Consequently, it has become easier for me to participate actively in the patent application process. My increased knowledge of patents in general has also increased my interest in applying for new patents".

Kristoffer Larsen Innovation A/S believes that the interaction he has had with the DKPTO and the knowledge he has gained from his experience with the dealing of the patent system, has had an important influence on his innovation activities and will continue to have so. He claims that if his patent ideas were refused, or if he receives only one patent out of the three, he will no longer be as enthusiasticly innovating.

Kristoffer Larsen Innovation A/S's work with inventions is first and foremost based on his own ideas and knowledge and he rarely gets inspiration from others inventions. He has not used the patent literature for gaining new knowledge. Also, Kristoffer Larsen Innovation A/S finds it fairly difficult to understand the patent literature because it is written in English and legal terms are used. In general it is Kristoffer Larsen Innovation A/S's assessment that his involvement in the patent application process has not increased his technical knowledge. Also Kristoffer Larsen Innovation A/S claims that his involvement with the DKPTO has not increased his knowledge of competitors and the market. This of course might be due to the lack of innovations of equipment for out-door pigs. As the pork industry analysis illustrated inventions of equipment for outdoor pigs are normally not patented and therefore information on Kristoffer Larsen Innovation A/S's market conditions, competitors etc. cannot been pulled out of patent information. In conclusion, Kristoffer Larsen Innovation A/S's interaction with the DKPTO has first and foremost been vital in connection with his specific applications, but has also increased his knowledge of the patent system and increased his skills in applying for patents and judging relevant claims for the patent.

5.4.5 DKPTO's gains from the interaction with Kristoffer Larsen Innovation A/S

Kristoffer Larsen Innovation A/S describes the relations to the case officer Michael as informal and personal. Kristoffer Larsen Innovation A/S has for instance held several meetings with Michael and they often talk over the phone. Kristoffer Larsen Innovation A/S has often asked Michael for advice and they have discussed Kristoffer Larsen Innovation A/S's situation and possibilities in the patent system. The level of interaction between the two parties has been fairly extensive. It is also Kristoffer Larsen Innovation A/S's belief that the DKPTO and especially Michael has benefited from the collaboration. Michael has been looking from the sideline and became aware of which types of problems one faces, when applying for patents for the first time. The intense involvement enables case officers as Michael to answer questions in the future, which goes beyond questions on how the patent system works and formalities in the formulation of the patent application. The case officer gains insight in the types of questions you might ask as a first time applicant and the surprises customers get when the cost of an international patent is first revealed, the procedures and complications of sale of the inventions, license deals etc. The case officer also becomes aware of which supporting possibilities there might be such as network possibilities, where to get technical advices, or which funds you can apply for if needed. This type of information can then be passed on to new applicants and so help them get through the system in the most efficient way.

5.4.6 The usefulness of a national patent office

Kristoffer Larsen Innovation A/S believes that the contact with Danish patent office has been fruitful due to the good communication. He doesn't think he could have communicated in the same manner if the patent system was centralised and all patent activities were placed in Munich. Kristoffer Larsen Innovation A/S mentioned the foreign language as a main communication barrier. He also fears that a centralised patent system easily could be slow and bureaucratic. Also Kristoffer Larsen Innovation A/S points to the fact that the national patent authority gives better possibilities for continuous dialog and interaction.

"... I have held meetings with the DKPTO and I frequently speak with Michael over the phone. I don't think this communication would have been possible had there not been a national patent office. Besides you learn much from this informal communication and it is nice that you can easily get a quick answer."

When you as a patent applicant choose to get involved in the patent application process as Kristoffer Larsen Innovation A/S did, it is undoubtedly an advantage that you can call the same case officer and get some advise in questions concerning the use of the patent system. In addition, you can more easily be directed to the right person or institute if your questions go beyond what the patent office can answer. Also Kristoffer Larsen Innovation A/S mentions that the personal relations to the DKPTO has meant much to him in his work with patents, and he doubt that this type of relationship could be maintained if the patent system was fully centralised and his case officer was in Munich.

5.5. Østjysk Innovation (pre seed capital provider), Pure Snack (a company financed partly by Østjysk Innovation) and the Technological Institute (a GTS institute)

Several of the innovating institutes mentioned in section 3.3 are frequently users of the DKPTO. In their work with establishment of new innovating companies and commercialisation of research, the institutes become involved in patent questions.

In this case the two innovation supporting institutes Østjysk Innovation (a pre-seed capital provider) and the Technological Institute (a GTS institute) are used to illustrate how these types of organisations handle the work with patents and to illustrate their interaction with the DKPTO. In order to illustrate the interaction between the institutions and their portfolio companies, a one-man company Pure Snack is included. Pure Snack is supported by Østjysk Innovation[50] and seeks to commercialise low fat snacks. The case study is based on interviews with Gyda Bay from Østjysk Innovation, Peter Lauridsen (the Technological Institute, Invention department) and Ole Knudsen (Pure Snack).

The most important function of Østjysk Innovation and the Technological Institute is to support entrepreneurs and researchers commercialising inventions. The institutes help the inventors with

[50] Østjysk Innovation owns from 25-49% of their companies they are supporting financially.

guidance in such questions as licensing, marketing and sales related questions. Both institutes also support the companies financially and in creating networks, the two types of support that they provide in the area of technical guidance. The GTS institutes have in-house engineers and consultants with expertise within several technical areas. The experts' job is to help inventors to develop or improve their inventions, and to help the commercialisation process.

These institutes see patents as very important elements in this process. They spend much of their resources supporting companies in their work with patents. Even though it is costly, both institutes encourage the inventors to apply for patents. For instance, the Technological Institute inform the potential inventors of the national as well as international patent bureaus, as well as explaining and their areas of expertise area and provide guidance in patent related questions.

In Østjysk Innovation the judgement of the companies' likelihood of receiving a patent is crucial in decisions of which inventors to fund. Gyda Bay says,

… When we in Østjysk Innovation select the companies we wish to support financially, we look at the products, business opportunities, and the chances of the invention being commercialised with or without a patent. Judgement of the possibilities of gaining a patent can be crucial when it is decided whether to invest in a project or not, depending on the market competition situation. However, we do take into account if a company is choosing a concealment strategy (Gyda Bay, 2001).

Both Institutes use in-house expertise to screen for novelty and buy novelty searches (patent technical searches) from the DKPTO or from the patent bureaus. The institutes use the searches to screen for existing patents within a certain area in order to estimate the patentability of the invention. The in house novelty screenings are carried out in free databases available on the Internet and in databases where the institutes have paid to get access to. They are accessed on-line and in CD-ROMs issued by the EPO.

In addition to using the DKPTO to carry out novelty searches, Teknological Institute also uses the DKPTO to acquire new information in the patent area, and are participants of the many seminars DKPTO offers.

… In the beginning of the 90 s, we used DKPTO´s services much more. We bought much of novelty searches and state of art searches, which is a service to researchers to inform them of the patent activities in their field of research. Today we buy fewer novelty searches from the DKPTO. This is due to the fact that the subsidies we get from the Danish Agency for Trade and Industry is reduced and because we now have access to online patent and literature databases and has learned to make better searches (Peter Lauridsen, Technological Institute, 2001).

Our "state of the art" program was a popular service to researchers and besides the general information value, by the scientists sometimes used the searches to adjust their research into areas where less patents were taken, Peter Lauridsen says.

Like the Technological Institute, they only buy novelty searches in Østjysk Innovation. Gyda Bay mentions that they buy a limited number of novelty searches depending on the subjects while patent bureaus can provide more information in the novelty search in certain subjects. If the business ser-

vices were cheaper as Gyda Bay believes, then that Østjysk Innovation would buy more searches especially patent infringement searches would be useful, she claims.

Østjysk Innovation uses the novelty searches as one of many factors to make final decisions on whether to support a project or not. Ole Knudsen of Pure Snack recognises this situation. Luckily, the novelty search for his invention had a positive outcome leading Østjysk Innovation to support his business financially and to help him get a licensing deal. The novelty search was also useful in the process with getting investors, Ole Knudsen suggests. Also Ole Knudsen believes that a novelty search from an authority is viewed as reliable among investors; a strategy to consider for competitive advantage and so it might be an advantage to buy the searches of authorities.

Ole Knudsen has not used the novelty search to get information of competitors or the market and this is due to the fact that Ole Knudsen hopes to sell his intellectual rights as soon as possible and move on to work with new inventions. Today Ole Knudsen has only communicated with DKPTO twice. When he first started to think of patents as a way of getting on with his work, he called DKPTO and they send him some introduction brochures. The material was good and easy to understand and it gave Ole Knudsen a good view of what was included in a patent application and the process of patent application. The second time Ole dealt with the DKPTO was recently when he bought a novelty search.

Due to their relatively smaller budgets, both the Technological Institute and Østjysk Innovation buy few novelty searches from the DKPTO. The two institutes sometimes choose to buy the business services at other suppliers than the DKPTO, for instance from the international authorities in Stockholm or the EPO (Münich). A reason for this is that a company that is interested in the invention often demands a search from the international authorities when they evaluate a license agreement. If the Technological Institute buys their novelty search from a patent bureau it is mainly because they have chosen this particular bureau to make the patent application. Another reason for using a bureau and not the DKPTO in the initial search process is that the DKPTO is not allowed to discuss an invention's patentability evaluation prior to an application. According to general public law, the DKPTO cannot give such premature evaluations as the DKPTO also holds the national authority of granting patents.

Østjysk Innovation chose to let the patent agents carry out their search because they have experienced that some of the patent agents are doing a better job within some technical areas. Also Gyda Bay finds it convenient that the patent agents can pass remarks on the searches and make comments on the chances of getting the patents and chances of infringement of other patents. Due to legal concerns, the DKPTO is limited and cannot discuss such elements with customers.

As a rule, both institutes leave the formulation of the patent application to the patent agents and the rest of the work that follows, but the institutes also function as impartial brokers between the inventor and the patent bureaus in order to optimise the patent process. The institutes seem to follow the same procedure as nearly 80% of DKPTO customers[51].

[51] This figure of 80% of the customers is in a way, indirect customers, because they are buying services through the patent agents. The patent agents so are the direct customers.

Even though the three respondents leaves much of the patent work to the patent agents, they still believe they have learned much from dealing with patent questions. In general it is difficult for the respondents to point out the origin of their knowledge. Some knowledge might have come from directly from interaction with the DKPTO, seminars in Denmark, abroad, and some from the patent agents, according the respondents.

Peter Lauridsen mentions, that there are a large number of employees from the Technological Institute, who have learned much from joining DKPTO's introductory courses and seminars in intellectual property right issues. The courses has increased the qualifications among employees in the work with patents and contributed to a better awareness of intellectual properties in the Technological Institute in general.

Neither Gyda Bay, Ole Knudsen nor Peter Lauridsen believes their interaction with the DKPTO has increased their technical knowledge from their interaction with the DKPTO. However, Gyda Bay hasheard of inventors who have spent a day in DKPTO's library that resulted in photocopies of patent literature which were to be used as inspiration for new inventions. Gyda Bay believes though that that it is rare that the inventors use patent literature directly for new inventions. This is due inventors already have great knowledge in their field of work, according to Gyda Bay.

5.6 The need for a national patent office

None of the questioned institutions believe their member companies would have applied for fewer patents, if the DKPTO had not existed. However, all three respondents find it convenient to have a national patent office due to shared language and culture, also and the close localisation. Peter Lauridsen says,

… It is always nice to have the help on one's doorstep and not externally placed in Stockholm or Munich. Unfortunately, I think there is a tendency towards further centralisation of the patent system and it might very well lead to the EPO running the whole thing (Peter Lauridsen, 2001).

… It is always nice to have the help on one's doorstep and not externally located in Stockholm or Munich. Unfortunately, I think there is a tendency towards further centralisation of the patent system and it might very well mean that EPO will run the whole thing. Currently, all patents issued must be translated to the language of the respective country, but it seems that in future, for instance for a European patent, covering all countries of the European Community, it only has to be translated to a few languages. This will reduce the need for an official patent Institution in each of the countries. (Peter Lauridsen, 2001).

Gyda Bay states that it is of importance for the nation in general to have a national patent office. To the question: Do you think, the companies in your network would apply for fewer patents, if the DKPTO had not existed and all patent application had to be processed by a PCT authority? Gyda Bay says,

… Yes, I believe it would matter for the small companies who choose not to use a patent agent and so complete their own patent application. There are a number of inventors who cannot afford to hire a patent agent and they are better of with a national patent office. They feel safe with a national patent office and the communication is likely to be better. For most of the companies we invest in

it would not make a difference. (Gyda Bay, 2001).

Besides the advantages of close geographic localisation, the shared language and the shared culture, the respondents also mention good personal relationships with the staff in the DKPTO as an essential reason to preserve a structure with a national patent office.

5.7 The patent agents: Plougman & Vingtoft and Patentgruppen

Around 80% of the patent applications, the DKPTO receives are completed by a patent agent. This makes the patent agents a very important customer group and makes it necessary to evaluate the patent agents relationships with the DKPTO, their attitudes and their view of the DKPTO, as well as their expectations in future collaborations with the DKPTO. In order to answer these and other we have interviewed Peter Jensen[52] from Plougman & Vingtoft and Jørgen Møller from Patentgruppen. The two bureaus differ in size and also to some extend in the provided services. Plougman & Vingtoft is the largest patent agent bureau in Denmark and they support their customers technically in further development of inventions if necessary. The Patentgruppen consist of five patent agents and a number of other staff. The bureau is the fifth in size in Denmark measured by international patent applications in 2000. Patentgruppen also differs in its service offerings. In comparison to most bureaus the Patentgruppen is integrated in their customers innovation process. While most bureaus evaluate the final innovation output the Patentgruppen evaluate the patent possibilities of inventions early in the innovation process and continuously throughout the whole innovation process.

Both Plougman & Vingtoft and Patentgruppen consider the DKPTO to be more an authority and a sub-supplier, than an actually collaborator. The bureaus consider also their role in the system to be completely different from the DKPTO. According to Peter Jensen, a patent agents' role is the same as a lawyers' function when buying a house, instance.

… The customers ask the lawyer to help him buy a house and make sure that the trade is properly arranged. The lawyer fixes all the paper work and the customer does not need to worry about rules and regulation within the area. It is the same scenario that exists between the patent agents and the company who wants to apply for a patent (Peter Jensen, 2001).

The patent agents can be considered as an intermediary between the companies and the DKPTO and it is the patent agents who help the companies with the patent applications. The patent agents function is to represent the customer to the authority.

The patent agents' most important job is to work out the right patent strategy, which is drawing up the right patent claims. Due to regulations, the DKPTO is not allowed to handle this function. The DKPTO is also limited in the guidance that they can provide when selling business services[53]. When the patent agents sell a business service to their customers, they are allowed to comment on

[52] The real name of the respondent has been changed.

[53] On the other hand, as a patent authority the Dkpto is obliged to guide the applicant in a manner that ensure that his rights are fulfilled. This is, however, not guidance on the likelihood of acceptance of the application.

the company's chances of getting the patent. In general, you can say that the patent agents give advice to their customers, whereas the DKPTO is only allowed to guide customers. Peter Jensen sees this division of labour as a necessity because it gives room for both actors. Peter Jensen also mentions that their customers never address the DKPTO directly. The customers turn to Plougman & Vingtoft for answers and not obstacles and complexity. According to the two bureaus, the division of labour is clear, the DKPTO is a sub-supplier of business services and the issuer of intellectual property rights.

5.7.2 The bureaus' use of the DKPTO

Plougman & Vingtoft often buy business services. They buy various services like novelty search, patent family searches, and various surveillance searches (patent family surveillance, competitor surveillance, or technical surveillance). Plougman & Vingtoft buy the novelty searches for screening the market to get an idea of patentability. Plougman & Vingtoft also purchase business services from the DKPTO or other patent agents, who are specialised in documentation. Before they buy the searches, they usually make their own introductory searches.

Unlike Plougman & Vingtoft, Patentgruppen sometimes make their own final novelty searches before they determine whether to apply for the patent or not. Jørgen Møller says, that it is possible to make good online searches within some technical areas if the technical area is new, such as for the mobile phone industry, Jørgen Møller says. For such a case, all the relevant material on line, which makes it unnecessary to scan the DKPTO's patent literature. Furthermore, Jørgen Møller points out that the quality of the DKPTO's novelty search within certain technical areas is not always as good as expected. Such inconsistencies lead Patentgruppen sometimes to to make their own novelty searches or have others carry them out.

Both Plougman & Vingtoft and Patentgruppen usually apply for patents in the EPO. This is because the customers normally want to apply for patents in several countries instead of just one and so the fast way of gaining the patent is to apply for the patent at a PCT-authority.

Patentgruppen submits around 15% of all patent applications for trial in the DKPTO. This is because some of Patentgruppen's customers want to apply for patent in Denmark first in order to save time. Some companies are not sure of the market possibilities of the patent and some companies' want to reduce the costs involved with gaining the patent[54]. Unlike Patentgruppen, Plougman & Vingtoft has never filed a patent application at the DKPTO, but they hand in patent applications in Denmark for registration. According to Peter Jensen, their customers are not interested in a patent that is only effective in Denmark.

… Our customers are thinking internationally and there is a good reason to think that this tendency will continue in line with the increase in internationalisation.

In Patentgruppen they also believe that fewer of their customers will want a patent, which only is valid in Denmark, and thus fewer are likely to have their patent application tried at the DKPTO. Jørgen also mentions that the DKPTO probably will receive even fever applications when the cheaper Community patent is introduced.

[54] It costs10.000 DKr. to apply for a patent in Dkpto. It costs 40.000 DKr. to hand in a patent application in EPO. The starting cost is thus very different.

The two respondents believe that if the DKPTO wants to have more work with patent applications, it must utilise subcontracting. Both respondents like the idea of the DKPTO as a PCT authority. In extension of this, Jørgen Møller emphasises though that a prerequisite for a subcontracting system is a 'quality assurance system' has to be introduced to ensure that the services are uniform. Currently, the DKPTO has failed to implement such quality control, even if it is essential to subcontracting. Jørgen Møller suggest their experience has shown that the different authorities process patents differently and sometimes the outcome of a patent application is different as well.

… We have sometimes experienced that novelty searches handed in as a PCT-application has been made in Stockholm and where the result has been very poor. Conversely, we have never experienced that a novelty search carried out in the EPO in Munich has been of an inferior quality. Therefore, it is also my opinion that a quality assurance system is needed, if the subcontracting system is to work. Furthermore, if EPO is to contract out the entire trail process and the issuance of patents, it is important that assessments addressing patentability and inventive measures analysis need to be the same. Today, different patent offices have different expectation.

The patent agents do not gain much technical knowledge from their interaction with the DKPTO and thus almost no technical knowledge from the DKPTO is passed on to the inventors. The limited technical knowledge the DKPTO might pass on to customers, is to be found in the business services report, but there is rarely improvement in any of the customers' technical knowledge from reading these reports, Peter Jensen says. According to Peter Jensen, the patent agents have gained their technical knowledge from their education, journals and conferences, adding that usually the patent literature is not used for upgrading ones knowledge. However, the patent agents use the patent literature when they make their introductory search and it is likely that the patent agents gain some sort of knowledge when working with the patent literature. But the patent agents do not scan the patent literature to increase their knowledge, Peter Jensen says.

According to Peter Jensen there is no knowledge spillover from the DKPTO to Plougman & Vingtoft when they interact. Actually the work with patent application does not give rise to much interaction with the DKPTO or any other patent offices. Plougman & Vingtoft interaction with the DKPTO concerning patent questions is seldom , due to the fact that Plougman & Vingtoft applies for patent in the EPO. The only thing that is likely to give rise to knowledge spillover their employees' attendance at DKPTO's held courses in intellectual property rights. Plougman & Vingtoft's new employees often attend the introductory courses.

Both Plougman & Vingtoft and Patentgruppen are aware that many of the employees that the DKPTO train end up in private patent bureaus and four out of five of the consultants in Patentgruppen are from the DKPTO. Jørgen Møller mentions that it is an advantage to hire someone who have worked for the DKPTO because they know how the system works. The patent agents job is of course very different from the work in the DKPTO. The patent agents job is to formulate a description of an invention in a legal-technical way and to make the patent application as broad as possible by formulating the right claims. The staffs in the DKPTO dealing with the applications on the other hand, read and make a judgement of the application. Plougman & Vingtoft have only recruited a few employees from the DKPTO. Instead they often recruit PhDs from the universities. They be-

lieve are able to help customers with inventions, as well as recognise the opportunities in inventions than others[55], Peter Jensen says.

5.7.3 DKPTO's new role

The DKPTO can, because of it status as an authority, stimulate and contribute to networking among the actors in the industry. This fact both respondents agree upon. the DKPTO's status as an authority allows the organisation to fulfil a number of coordinating functions and to implement initiatives useful to society. Some of the initiatives the DKPTO has implemented are listed below.

- **Education/courses:** the DKPTO is together with Patentagentforeningen and DIP (Dansk Industris Patentagenter) coordinator of the Intellectual Property Right education in Denmark. Courses are held in intellectual property rights, consequences of changes in the international patent system, etc. The economy in the courses department is tight and it is unlikely that a private company would be able to put up the same type and variation of courses.

- **Conference organiser:** the DKPTO continuously hold conferences. They recently held a conference, in collaboration with patent agents, for 40 managers in a large Danish company. The purpose of the conference was to increase the manager's awareness and knowledge of intellectual property rights at a strategic level.

- **The spring meeting:** the DKPTO hold a spring meeting once a year. The participants at the meeting are usually 200 employees from the DKPTO, patent agents and the industry association. The purpose of the meeting is to have the players in the industry inform each another of their activities and to network.

- **Innovation Forum:** Once a year the DKPTO and the patent agents hold an event, where the invention of the year is elected.

- **Sparring Partner:** the DKPTO uses to a large extent people from the industry as sparring partners in product development. The DKPTO has for instant invented the program Ipscore and several publications at the request of the industry.

- **Information campaigns:** the DKPTO and four patent bureaus are currently working on a joint information campaign, which seeks to increase awareness of intellectual property rights.

- **Joint mouthpiece of the industry:** In m anyways the DKPTO works as a mouthpiece of the industry and especially in international questions. The DKPTO discuss political and international questions with the industry at meetings.

Peter Jensen says, that the DKPTO has done a good job gathering the industry during the last 4-5 years and it has been fruitful in terms of networking. Plougman & Vingtoft also participate in several of DKPTO's activities listed above.

[55] Plougman & Vingtoft does not cover all technical areas. They have specialised within the areas bio technology, chemistry and software technology.

… We always participate in the popular spring meetings. It is an event, which offers possibilities of creating networks. I think it is of high value that a public institute is able to gather the industry and create events where networks are established. In Denmark, the DKPTO is the catalyst for organising industry events and meetings because they are neutral.

Both at Plougman & Vingtoft and Patentgruppen, they are aware that the DKPTO's role has changed, and they expect a further change during the next couple of years. The DKPTO thus is more than just an authority, which issues intellectual property rights and a sub-supplier of business services. The DKPTO is also an organisation, which bring the industry together, while keeping the networking within the industry vibrant.

5.8 Case: Rockwool International A/S

The Rockwool Group is the world's leading manufacturer of stone wool. With more than 20 factories in Europe, North America, and East Asia, and a global network of sales companies and trade offices, the Rockwool Group covers all parts of the globe. The Group has more than 7,000 employees and the profit after tax was 106 mill. DKr in year 2000. The sale of traditional thermal insulation makes up 5/6 of Rockwool's revenue. The last 1/6 of revenue is from sale of other products based on stone wool insulation. The products are stone wool for acoustic control in ceiling systems, stone wool for noise and vibration control, sound- absorbing walls and stone wool used as a substrate for market garden production of flowers and vegetables.

Rockwool's headquarter lies in Hedehusene west of Copenhagen and include the Group Management and the central R&D. In Rockwool we got the opportunity to interview Arne Kraglund, who is responsible for the patent department, Technology Search. The department is responsible for patenting and technology, as well as competition surveillance based on review of patent literature. Today the patent department consists of five employees and is placed in Hedehusene.

The insulation Industry
Insulation material can be divided into two main categories. The first category is mineral wool, which is stone wool and glass wool, and the second category is 'foam' which is flamingo and others. Normally the choice of insulation is traditionally determined. In US they normally use glass wool, in South Europe they have a tradition of using foam, in East Europe they use stone wool and in Western Europe we use stone wool and glass wool. Glass wool is today the most sold insulation of the mineral wool products.

The mineral wool products differ in terms of their melting point. The melting point for stone wool is at almost 1000 degree, while the melting point for glass wool is at 600 degree. The products also differ in flexibility. Glass wool is more flexible to work with than stone wool, which can be an advantage as well as a disadvantage in the construction work. The price of the two products is basically the same and the consumer is likely to consider the two products, glass wool and stone wool as close substitutes.

In comparison to the mineral wool products, the foam insulation material burns easily and releases poisonous gases during a fire. Due to these poor fire properties, EU recommends that only mineral wool be used when fire properties are needed. Another advantage of using mineral wool in comparison to foam is that mineral wool is damp resistant and sound absorbing.

In the mineral wool industry there are a few larger players and several smaller players. The small players are insignificant in competition questions when the industry is considered as a whole. Rockwool, a Danish company is one of the large players in the Western European market for mineral wool. Today it has 30% of market share for mineral wool. Rockwool's largest rival is the French company Saint Gobains (market share of 40%.) that produces mainly glass wool but also stone wool. Saint Gobain has products in Denmark and is branded by the trade name: Isover. There are also a number of smaller players who are to be considered as Rockwool competitors. These are the Finnish company Paroc, the German company Pfleiderer and the Austrian company Heraklith. These three players have a decent market share, but they are smaller that Rockwool and Saint Gobain. There are also a number of large players at the American market who produces glass wool. However, these companies focus their products on the US market.

Throughout the last 7 to 8 years there has been a considerable overcapacity in the markets in Western Europe and at the same time a large part of the European market has limited their construction work. For that reason Rockwool has started to focus more on the Eastern European market and the Russian market. In these markets the money for construction work is still limited due to the poor economy, but it is expected that the situation will change in the near future. The overcapacity in the market and the lack of constructing work in Western Europe has lead to tough price competition. Due to the intense competition in the industry, the prices at insulation material has not gone up for about six years and Rockwool's earnings has been relatively low.

The price has been a crucial competition parameter over the years but improvements of products are also playing an important role in the competition race. Rockwool and the other large players made large investment in R&D, as well as on on patent activities. In the industry there is a tradition for using patents, which are considered an effective way of protecting new inventions. Recently Rockwool has introduced the new product 'Rockwool Silk' that was also patented. The new silk product has a comfortable surface on contact that makes the work with insulation much easier.

The large players in the industry are all very conscious about using patenting. In Rockwool for instant, they have a patent policy which states that Rockwool must protect its know how, meaning a patenting strategy is the best approach of securing their knowledge. Furthermore, the policy states that this strategy actively pursued whether Rockwool's existing patents are violated or not.

Today, Rockwool's products have a long lifetime and the products can be easily imitated, so gaining a patent is an important way of protecting their inventions and market share. Rockwool would never run the risk of not applying for patents on new important inventions, because they realize that their competitors are just behind them with their own inventive activities. Additionally, there have been incidents where the large mineral wool producers have handed in almost identical patent applications, according to the company. Arne Kraglund believes that if Rockwool in such environment had chosen a secrecy strategy, waiting until the market for the products has been investigated and sale prognoses had been made, it would have failed.

Rockwool and their way of using the DKPTO

Each year Rockwool hands in a large number of patent applications to both the DKPTO and to PCT authorities and today Rockwool's portfolio consists of more than 1000 patents or patent applications. Rockwool's patents are first and foremost product patents, but they also have patents on processes. Almost one-fourths of all Rockwool's patents are examined in the DKPTO and three-fourths

are examined at a PCT authority. Arne Kraglund says that if they are convinced an invention will become a success in a number of countries the patent application will normally be handed in directly to the EPO.

Rock wool's Patent Procedure and Rockwool's use of the DKPTO

The patent procedure in Rockwool begins with the inventor describing the invention in collaboration with someone from the patent department. Subsequently, the description is sent to the DKPTO, that as a consultancy service make a novelty search on the invention, in order to see if the invention actually is new. Rockwool does not buy novelty searches of patent agents. This is due in part to their confidence in the patent authorities and also because they know the authorities have substantial and current holdings of patent literature, Arne Kraglund claims.

When a novelty search has been conducted and the invention showed out to be new, considerations are made to whether to go on with a patent application. If it is decided to go on with a patent application, Rockwool's patent department will involve a patent agent and have them formulate the patent application. Rockwool uses both Danish and foreign patent agents.

Rockwool buy two types of business service from the DKPTO, novelty searches and state of art searches. The novelty searches are bought in patent application context and are used to make final decisions on whether to go on with a patent or not. The state of art searches are not used directly in the patenting process, but more as information material used for R&D. The state of art searches has for instant been used to give a better insight in a certain technical area and as a tool for generating ideas. However, Arne Kraglund points out that they have experienced that the searches don't give too much direct inspiration, so rarely do they buy the searches. According to Arne Kraglund, the inventors from R&D department work after own ideas. They focus on certain problems, and then seek the appropriate solutions. The state of art searches are mostly useful if they address R&D outside Rockwool's key competencies. There is not much knowledge to gain from the patent literature of Rockwool's key product, stone wool,

... The state of art search and the patent literature in general might gives us inspiration for the work with R&D which lies outside ours key competences, stone wool. We have cutting-edge leading knowledge in stone wool is not much knowledge we can gain from patent literature. (Arne Kraglund, 2001).

Arne Kraglund mentions that they have sometimes found useful technical solutions in the patent literature when they have worked with solutions outside Rockwool's key competences. For example in the patent literature from the textile industry much of inspiration can be gathered.

Today the patent literature is not used directly for developing Rockwool's key products. Arne Kraglund acknowledges that it of course might be difficult to say exactly where the inspiration comes from with inventions. However, there seems to be a tendency that most ideas come from hard R&D work and from speaking with colleagues. The inspiration does not come from systematically searching in the patent literature, Arne Kraglund notes. And the effect of their work with the patent literature (surveillance of competitors) on the R&D activities is hard to see. However, Arne Kraglund believes, there is some sort of effect, but it might very well be indirect.

Rockwool's relationship to the DKPTO

Rockwool have a contact person in the DKPTO and it works out well. It is nice to always know which person to contact, Arne says. When Rockwool orders a novelty search it is directed to the contact person and he forwards the task (assignment er en overdragelse af rettigheder i patentverdenen, derfor korrektionen) to the person who is to carry out the search. The person who ends up getting the task will subsequently call Rockwool and make sure that the description is properly understood. Arne Kraglund finds it convenient to have such good relations to the DKPTO:

...I don't just call the EPO and they do not call me to ensure they have understood a description correctly. I can definitely feel that the geographic distance to the EPO is long. Besides I like the idea of knowing the person I am calling and that is the case when I am calling the DKPTO. It gives one some sort of security that you know the people who are dealing with your patent applications and searches and also much can be unsaid if it is always the same person who is dealing with your company (Arne Kraglund, 2001).

According to Arne, it means much that there is a good understanding between the DKPTO and Rockwool and he likes that the two parties are close geographically. Because the geographic distance is short, we can easily meet if it is necessary, noting they actually meet once a year to discuss their collaborations, Arne Kraglund says. At these meetings, Arne Kraglund is asked to come up with ideas to improvement the effectiveness of the DKPTO and assess their customer-client relationship. This leads to the belief that it is likely that the DKPTO has learned from its collaboration with Rockwool.

The advantages of having a national patent office

Rockwool supports the national patent office. However, Arne Kraglund thinks that Rockwool would do just as well without a national patent office amongst other because Rockwool have many years of experience with the patent work. But for the sake of small companies and newly established companies that might be low on cash, Rockwool supports the national patent office. From a society point of view Arne Kraglund believes that there is a necessity for a national patent office, adding that it is also convenient.

5.9 Conclusion

5.9.1. The contribution of patent literature and -information to technology spillover in the innovation system

None of the respondents believes that they have increased their specific technological knowledge through their interaction with the DKPTO. The patent literature and information (on which business services are based) as well have only to a limited extent contributed as inspiration to new inventions. Two of the respondents (Arne Kraglund, Rockwool and Peter Lauridsen, Technological Institute) mention that they have used the state of art searches as inspiration for new inventions, however, not very often. At the Technological Institute, these type of searches has also been used for adjustment the direction of future inventions.

Several of the respondents mention that their searches in the patent literature might have led to some inspiration. However, the respondents do not believe that searches in the patent literature, whether it is the DKPTO or the respondents own searches, are crucial in their work with inventions. In general, it is believed that the technological knowledge that might be gained from patent literature is indirect. This result is no surprise and it is widely supported by research concerning the general importance of patent literature to the innovation process. For example, it is reflected in table 3.1., in which patent literature rank relatively low as a source of ideas for innovation.

The respondents claims that the reason why patent literature or business services based on patent literature rarely is used directly for new inventions, is that the employees of the R&D departments or inventors in general are experts within their own technology field and therefore there is no reason to look in the patent literature for final solutions. If inventors are well-connected within their field, they are more likely to speak with other experts or read technical journals.

5.9.2 The DKPTO's contribution to increasing knowledge and awareness of IPR and to facilitating access to IPR protection.

The respondents claim that they have learned much from their work with IPR and it is difficult to point out from where the knowledge comes. The patent applicants might get some knowledge from their interaction with the DKPTO, other patent authorities and the patent agents. Several of the respondents meet and talk with the DKPTO and patent agents when first starting to think about applying for a patent or formulating their applications and so the learning form 'learning by interaction' seems to take place.

The case stories show that the patent applicants learn much from working with patent questions on their own. So the learning approach 'learning by using' does also seems to be of great importance. Also, all the respondents clearly have gained a higher absorptive capacity from dealing with patent questions; they are all able to read and understand the patent literature and the inventors are today better at giving full descriptions of their inventions or to codify an invention.

With respect to learning effects of interacting with the DKPTO, one should bear in mind that the size of the firms in the case studies is relatively large, except for Kristoffer Larsen's. This may have a bearing on learning effects, as one should expect learning to be most intense during the first times of interaction. Thus, a large firm with it's own patent engineers, or even patent department, may have learned much when they were to apply for their first patent. However, when having developed internal competences on a high level, it is likely that learning effects are minor. Vice versa, small firms may have disproportional higher learning effects.

5.9.3 The importance of a national patent office

None of the respondents believe it would be negative for their patent activities, if the patent system were fully centralised in Munich and several of the respondents mention that they are indifferent to where they buy their business services. The business services can be bought from the DKPTO, other patent authorities or patent agents. Several of the respondents also claim that it is just as easy to hand in a patent application to the DKPTO as in the EPO.

Even though the respondents do not think that they would apply for fewer patents if the DKPTO had not existed, they all mention that it would be unfortunate to be without a national patent office.

The respondents all agree that it is convenient to have a patent office in Denmark because of the shared language and culture, it is easy to meet and call and also because the respondents have good personal contacts in the DKPTO. Some of the respondents also mention that the DKPTO hold good courses in IPR. Furthermore, the patent agents interviewed believe it is nice to have a national patent office to bring together the patent industry and to promote networking. So all the respondents could point out advantages of the national patent office. Even if they are themselves representing (except one) relatively large firms, then some of them point to an additional benefit of a national patent office for small firms.

Therefore, the case studies do lend some support to the proposition that national IPR institutions help diminishing the "transaction costs" of obtaining IPR protection. As such, some of the respondents tend to believe that national entries to patent protection lower the practical, bureaucratic, and communicative barriers for small firms of applying for patents. However, when asked directly the respondents feel confident that they (personally) would also be able to cope with a centralised European patent system.

6. Perceived effects of Dkpto on the knowledge of the firm

6.1 Introduction

Whereas chapter 5 focused upon selected cases where learning effects are likely to prevail, this chapter will take another approach. It uses quantitative methods to explore whether the learning effects are general phenomena or only present in theory, as discussed in chapter 2, or in selected cases, as discussed in chapter 5. This research question is answered by analysing data from a survey designed for this special purpose. Recognising the limitations in quantitative methods to reveal a complex phenomenon like knowledge and competencies the survey is a suitable method for getting an overview of the impact of the DKPTO as perceived by the customers. In particular, the survey may help us assessing the role of the DKPTO in innovation processes.

Having said this we do recognize that quantitative methods may only take us some of the way in understanding the way the DKPTO operate. One complication is that IPR is many other things than patents. Firms value different measures of appropriating returns from innovation differently, even within the firm different products may require different strategies for protection[56]. This is supported by an earlier survey of Danish manufacturing firms and their means of appropriation (DKPTO, 2000). In that survey it was found that patenting firms are also those who use other appropriability measures to a larger degree than the average (ibid., p.14). The survey also confirmed other studies on what are the most frequently used measures for protecting product innovations. 61% of firms used lead time advantages, 54% secrecy. Patenting ranked fifth out of eight with 38% of the sample having used patenting.

6.2 The design and implementation of the survey

The questionnaire was developed through several iterations and then tested on a patent director in one of the largest firms in Denmark. It was inspired by the theoretical considerations developed in chapter 2 and by the case studies reported in chapter 5. The questionnaire was designed to render clear answers and to keep the interview within limited time. The average time spent on the interviews was 12 minutes.

The sampling was done by using two sources. Our primary interests were firms who had both applied for patent and had experience with services from the DKPTO. From the DKPTO, we obtained two databases, one of firms who applied for patent within the past 3 years, and one of customers who bought services. These bases were 1865 and 625 firms respectively. The common share made up 143 firms. As our target was 200 interviews, the 143 firms were interviewed first, then supplemented with the base of services customers. The former list of firms was reduced to 140 after cleaning for double registration of observations closed down firms etc., and the latter list made up 361 firms. Re-dials were set to 25 before giving up reaching the relevant respondent. Three trained and carefully instructed interviewers undertook interviews in the period 11th – 27th September. Neither respondents nor the interviewers had problems with any of the formulations of the questions.

[56] For an empirically based discussion on this issue, see Arundel (2001).

As the resulting sample therefore seemed realistic or even perhaps too small compared to the target of 200 interviews, it was during the process decided to go for emptying the entire sample. This resulted in 290 interviews of which 77 stems from the 140-group, that is firms that applied for at least one patent. In this group, the response rate is thus 54%. The overall response rate showed to be 290/501 = 57.9%, which is satisfactory, especially considering that pure abstaining from participation happened in only 49 cases, and 30 interviews were terminated before completion. The remaining 132 non-responding cases showed to be either non-existing, or for other reasons not able to get in contact. As mentioned 77 interviews were performed with firms who were in the 140-group. Out of the remaining 213 firms interviewed a surprisingly 95 firms claimed to have had no contact with DKPTO. This relatively large share is surprising considering that the firms are listed in the customer base of the DKPTO Sales and Marketing department. The interviews with these 95 firms were consequently terminated after only a few questions (3 minutes). Our realised sample thus consists of 195 useful interviews. This is not only sufficient to make a breakdown by various variables, it also reflects the actual population. In other words, there is no way of increasing the number of respondents beyond what has been obtained.

Non-responses were unsystematically distributed. We can therefore regard the data, as reflecting the total population and no weighting of the data is necessary.

There are large differences in who are the relevant respondents in the firms. In large firms there may be a special section dealing exclusively with intellectual property rights, whereas in small firms it may be the owner. There were a large number of the firms that had the head of production/products handling these matters. Consequently, the interviews started with a filter process, identifying the relevant person to be interviewed. In order to make clear that the interview is not solely on patenting but rather a broader range of services from the DKPTO it was mentioned explicitly in the introduction what is the subject of the interview, and examples were given on what are services more precisely. Many firms use patent agents to handle matters regarding their intellectual property rights. As we were particularly interested in the effect of the DKPTO respondents were asked to state if they used patent agents alongside the DKPTO (60% of the group of firms in the sample with a priori assumption on patent applications claimed to have used patent agents for services[57]). They were subsequently asked to disregard the cases where only patent agents handled their case.

The presentation of results from the survey is organised in three sections. Firstly, structural characteristics of the firms in the database are highlighted. This section is kept relatively short, as most of this information can be obtained from the tables and needs few comments. Basic characteristics of the realised sample are presented below by means of five tables. The realised sample is broken down on size, number of patents applied for, year of establishment, year of first contact with the DKPTO, innovations. Secondly, knowledge flows from the DKPTO and potential effects of this is analysed. In particular, innovation effects are emphasized. This is regarded as the central issue in the survey. Included in this section, knowledge flows from firms to the DKPTO is in focus. Thirdly, the survey analysed what were the opinions of firms on the importance of having a national patent institution.

[57] There is a tendency that large, early established firms with a long record of Dkpto contact also use patent agents.

6.3 The characteristics of the realised sample.

In the following section, we shall focus upon only a few of the characteristics of the sample. One of the often-used background variables of data on innovation and innovation related issues are the size of firms. Many surveys have found substantial differences across categories of firm size.

In the present survey table 6.1 shows our sample by firm size.

Table 6.1. Survey sample by firm size in full time employees in Sept. 2001.

Number of employees	*N*	*%*
0	3	2
1-9	52	27
10-99	52	27
100-499	47	24
>500	38	19
Do not know	3	2
Total	254	100

The average firm size was 280 with a median of 30. This, together with the fact that 43% of firms have 100 or more employees, makes our realised sample relatively large-firm dominated by Danish standards.

Even if intellectual property rights is indeed many other things than patents it is often the patent activity of firms, which is in focus in the literature and empirical investigations of IPR. In our sample several of the organisations interviewed should not be expected to have patents as they are natural buyers of services but are not themselves developing new products or processes. One such example is research parks, which inform their companies about intellectual property rights and therefore need information and courses from the DKPTO, but they do not necessarily (although they could) have patents themselves (see case in chapter 5). In the sample, patenting is nevertheless widespread. Thirty percent of the firms had no patent applications.

Table 6.2. Number of patent applications through the DKPTO within the past 5 years

Number of patent applications	*N*	*%*
0	59	30
1-2	51	26
3-5	33	17
6-20	23	12
>20	23	12
Do not know	6	3
Total	195	100

The average number of patent applications was 18 with a median of 3[58].

[58] In the survey by Dkpto (2000) the median of patents granted was also 3. The two surveys are not directly comparable because the Dkpto-survey focused upon SMEs within the manufacturing industry, whereas this survey covers all industries and all size catagories. The medians will, though, tend to be fairly equal.

Two other characteristics are exposed below. We regard the year of establishment as an important parameter in assessing the firms vis-à-vis the DKPTO, because it may be the case that young, or even new firms/single entrepreneurs, are less aware of the opportunities of interplay with the DKPTO. In somewhat the same vein the year of first contact with the DKPTO may be important information, because for example a large, old firm who have had a long-term, frequent contact with the DKPTO may not learn much from the DKPTO any longer, whereas the same firm may have benefited substantially from the first years of contact[59].

Table 6.3 and 6.4 below show these two features.

Table 6.3 Year of establishment.

	N	*%*
1960 or before	71	36
1961-1990	64	33
1991 or later	49	25
Do not know	11	6
Total	195	100

There were 69 percent of firms with more than 10 years old, indicating a sample of relatively large, old firms. On average firms are established in 1963 with a median of 1978.

Table 6.4 Year of first contact with DKPTO.

	N	*%*
1980 or before	43	15
1981-1990	34	12
1991-1997	50	17
1998 or later	54	19
Do not know	14	5
Had no direct contact	95	33
total	290	100

On average firms had their first contact with DKPTO in 1987, with a median of 1995.

It may be worth noting in table 6.5 below that the firms in the realised sample are also relatively innovative. Thus, at least 60% have introduced an innovation within the past year[60]. It is likely that a large share of respondents answering, "do not know" is highly innovative, but just do not know the exact number of new products and processes[61].

Table 6.5 Number of innovations within the past year.

	N	*%*

[59] In a pilot test of the questionnaire a large Danish firm emphasized this point.

[60] As a rule of thumb, roughly half of the manufacturing firms in Denmark have introduced a new product or process during the past two or three years, according to a number of survey on innovation in Denmark (e.g. Christensen & Kristensen, 1994, Christensen, 2000).

[61] This was the case in the pilot test of the questionnaire. The test respondent would answer that question with " much", as he was not able to have a sense of the correct figure.

0	26	13
1-2	37	19
3-9	45	23
10 or more	36	18
Do not know	51	26
Total	195	100

The average number of innovations was 13 with a median of 4. Innovation intensity, calculated as the number of innovations divided by number of full time employees in the firm, is 0.86 and 0.1 mean and median, respectively. On average 16 persons in the firm are occupied with innovative activity (median 4 persons).

6.4 Potential effects of knowledge flows from the DKPTO

In chapter 2 theoretical considerations on the flows of knowledge were developed. It was pointed out that learning processes are said to be extremely important in innovation, and that often learning takes place in interaction. In this case, the interaction is between the DKPTO and firms, and we are interested in knowledge flows both ways between the parties. Moreover, we are interested in the effects of knowledge flows.

A first step towards accessing the question in the headline is to make clear to what extent is knowledge flows actually taking place. Asking the firms directly on this issue, both in relation to a specific task and more generally, we find that according to the firms in our survey the assessment of this vary from not at all (6% and 11% in relation to a specific task and general knowledge on IPR respectively) to Very large extent (14% and 9%). A majority sees the knowledge generated through the interplay with the DKPTO to be to "some degree" or more. It is to be expected, that at least some learning effects would be reflected in the responses. It is, however, uncertain what level one should expect, as we do not have any good measures for comparison. The results in table 6.6 and 6.7 are consequently difficult to access.

Table 6.6: The degree of learning in the firm from interacting with the DKPTO on a specific task %.

Not at all	*To a small extent*	*To some degree*	*much*	*Very much*	*Do not know*	*No. of obs*
6	18	33	27	14	2	195

Table 6.7: The degree of learning from interacting with the DKPTO re knowledge on IPR generally. %.

Not at all	*To a small extent*	*To some degree*	*much*	*Very much*	*Do not know*	*No. of obs*
11	22	29	25	9	4	195

It is to be expected that knowledge flows are more productive in terms of learning when it is on a specific task. This seems indeed to be the case, although differences are not big.

There were no differences between groups of firms like firms of different size, number of innovations, year of establishment or first contact. This could be said to be somewhat surprising. One should perhaps expect small, new firms to learn more. This is not the case. In fact, if anything

should be concluded on this issue it would be the opposite as there is a tendency among firms who claim to have learned nothing or only little on IPR generally from the DKPTO contact to be established in 1998 or later. The discussion in chapter 2 pointed to the fact that absorptive capacity of the receptor may promote learning. It may be that highly innovative or large firms are more prone to learn. Later we shall investigate further on this issue.

When focusing upon firms who attach importance to the learning in the DKPTO interplay we can assess what is more precisely learnt in the interaction. As displayed in table 6.6 and 6.7 above 41% of the firms attach either great or very large effects to the DKPTO interplay on specific tasks, whereas 57% think the impact has been some, small or none. This is a commonly used way of calculating so-called "high scores" when a 5-point Likert scale has been used in the questionnaire. Table 6.6 shows a considerable polarisation of answers and a corresponding disagreement concerning the degree of learning from interacting with the DKPTO. Regardless, a substantial part of the respondents scored "high" on this question. The "high scoring" firms give the following priorities on high scores, when asked to specify what are the most important things learnt.

Table 6.8: Contributions of DKPTO interplay. High scores/shares. ***N***=191

Contribution	*%*
Increase knowledge on and use of intellectual PR generally	29
Guidance re applications	24
Increase knowledge on the competitors	15
Increase the general level of competence within the firm	11
Increase the technical know-how of the firm	9
Increase the ability to develop new products or processes	8
Increase the R&D activities of the firm	7
Strategy	6
Increase knowledge on the market	6
Relations to other knowledge institutions	5
Provide Contacts and networks	5
Increase collaboration with other firms	3
Other contributions (share who list one or more)	23

- In the table high scores are calculated in the usual manner: Share of respondents answering Very large effect + large effect compared to all responding.

The results show that firms primarily see the contribution of the DKPTO as increasing their general knowledge on IPR. Secondly, the DKPTO plays a role in the application phase. These two are by far the most important contributions from the DKPTO. Calculating what could be patterns with respect to firm size, number of innovations. We find very few clear relationships. The exceptions are that firms that experienced a large or very large effect from the DKPTO on their R&D-activities generally seem to have learned much from the interaction with the DKPTO, both in relation to a specific task and more generally knowledge on IPR. The same holds for firms who experienced an increase in the general competencies of the firm (which should be expected as these categories are highly related), and for (the few) firms who experienced an effect on the development of strategy of the firm[62].

[62] Recently (2001) Dkpto has launched an information campaign highlighting the need for firms to think

The results generally resemble those of the case studies in chapter 5. It is evident from the results that the stimulation of innovative capabilities is not seen as a major contribution from the DKPTO. High scores rank low, and 45% of firms see the contribution in this respect as zero. Compared to table 3.1 on information sources for innovation, this is not very surprising. In that table, patent disclosures and institutions were assessed as having a minor importance in stimulating information to innovation activities.

Even so, the category "Increase the ability to develop new products and processes" is crucial to the present research. Therefore, we need to focus somewhat more on the answers to that question, and see who are the firms in either two categories. Below the firms answering not only high scores but also some (an additional 20%) to this question is grouped in one segment, and the rest of firms in another. They are then further sub-divided into different categories and all other variables are calculated on the background of this grouping of our variable.

The results from these calculations render no clear pattern on any of the other variables in our survey. The data reveals no special characteristics about the firms who indeed see the DKPTO as increasing the ability of the firm to develop new products, processes or services.

It was explained in chapter 1 and 2 that indeed it is likely that the learning effects from the interaction is mutual – that is the DKPTO is likely to learn from the interaction with firms just as firms are likely to learn. Arguments for this are related to the interactive character of learning as discussed in further length in section 2.4. The respondents were asked their opinion of what they thought DKPTO may have learned from them. This is, of course, a rather difficult question, and the answers should be taken with great caution and as an expression of what is perceived by the respondents.

Table 6.9. Perceived impacts within the DKPTO of contact to the firm, %.

None at all	*Small*	*Some*	*Large*	*Very large*	*Do not know*	*No. of obs*
49	22	14	6	3	8	195

The results indicate that the learning effect on the DKPTO is limited if measured as a share of the firms perceiving what was their impact. Similar conclusions were from the cases in chapter 5. However, it may be that the DKPTO only need one customer to learn much. In other words, the few customers who really produce learning within the DKPTO may be very important devices for internal competence building in the DKPTO.

When broken down in more detail the data shows that there are clear indications of the firms producing learning in the DKPTO are large, old, innovative and with a long history of DKPTO-contact. For example, a total of 9% answered that they believed to have stimulated knowledge within the DKPTO. This is to be compared with a frequency of 16% within the group of firms with above 500 employees, 16% within the group of firms with 10 or more innovations, and 21% within the group of firms with first contact with the DKPTO in 1980 or before.

We are also able to go a step deeper in this question and to identify in more detail what are the perceived effects. Firms who claim that they think that learning effects have taken place were asked to

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strategically about their appropriability measures, and how to incorporate this in the overall strategy of the firm.

specify what type of knowledge has resulted. Note that this greatly reduces the number of observations.

Table 6.10 Contributions to the DKPTO of DKPTO-firm interplay. High scores/shares.

Contribution	*N*=86	*%*
Increase the technical know-how of the DKPTO		11
Increase knowledge on the market of the customers		9
Increase the ability of the DKPTO to help other customers		9
Increase the general level of competence within the DKPTO		4
Other contributions (share who list one or more)		2

- In the table high scores are calculated in the usual manner: Share of respondents answering Very large effect + large effect compared to all responding.

The numbers are so small that reliability of differences between categories is questionable. However, it seems as if firms generally increase the technical knowledge of the DKPTO and the knowledge of customers.

In section 2.4, the transfer of knowledge was discussed. It was pointed out that tacit knowledge may be best transferred be means of what we labelled relational transfer, whereas codified knowledge may efficiently be transferred through transactional transfer. More specifically it was referred to studies that found the exchange of personnel in a product innovation project to be related to the type of knowledge needed (Vinding, 2001).

The channels of knowledge transfer are only partly indicated in the results above. One specific channel, which we have better knowledge on, is the mobility of personnel between the DKPTO and the firms interviewed. Answering the question ”Has your enterprise, now or previously, employed people previously employed with DKPTO”, it showed out that 12% confirmed that this has been the case. In other words, every 8th firm in the sample has a former DKPTO-worker in the staff. This is even a minimum figure as it is likely that some respondents are not fully aware of all the previous jobs of the staff. The estimation of the number of former DKPTO-employees is likely to be underestimated for other reasons: once the employee is working for some time in the new firm, the respondents do not think of that colleague as having benefited form external knowledge upgrading. Moreover, the need to interact with the DKPTO may be reduced when DKPTO employees are hired. The formerly DKPTO-employees primarily are hired by large, innovative firms with a long record of DKPTO-contact.

The question is if it is a high figure in comparison with other knowledge institutions. If we take the DKPTO as belonging to the research sector (higher education institutes, R&D-institutes etc.) a comparison can be made as, Langberg & Graversen (2001) made an analysis of mobility among researchers. They found that overall 20% of the employees leave the research sector each year (op.cit. p.27). However, if we dig deeper in the data we find that the mobility between (from) R&D-institutes and (to) private production sectors is only 4%. Many of the respondents in our sample are private production enterprises. Another big group in our sample may be characterised as services with respect to products. Langberg & Graversen (2001) estimate the mobility of this group to be 23% (from R&D-institutes to services). On this background, the above-mentioned 12% seem not that unusual. One may, though, question if it is the appropriate benchmark.

One of the hypotheses generated from this could be that previous DKPTO employees would stimulate the knowledge of the firm and the specific use of IPR. However, when answers of previous DKPTO employees are combined with answers on the question if DKPTO services have resulted in more knowledge and use of IPR there are no clear patterns. This is somewhat surprising as the implications of the theoretical considerations in chapter 2 are that absorptive capacity should increase. To get closer to a full picture of this important and interesting issue more research is needed. In a study based on survey data of mobility of knowledge-intensive staff Tomlinson & Miles (1999) found that such workers more often shift jobs, have lower tenure times and easily find another job. Even if this, indeed, have positive effects on the economy in terms of increased knowledge flows, then there is also negative sides, Tomlinson & Miles argue. They question the knowledge diffusion effect of inter-firm mobility of knowledge workers because inter-firm shifts are related to static knowledge, whereas intra-firm job shifts appear to foster more intense, and more long-term knowledge flows. Moreover, external job shifts may have negative consequences on organisational commitment. Therefore, transfer of tacit knowledge may be better promoted by means of collaboration and network rather than personnel transfer, Tomlinson & Miles asks. A final policy implication from their study is that there are limits to how far one should go in promoting labour market flexibility.

Another plausible hypothesis is that firms who employ DKPTO-staff are more patent-active. It shows that patent intensity – calculated as the number of patents per employee - is 2.01 and 0.64 respectively in firms with/without former DKPTO-staff (after cleaning for two extremes). This is a significant difference. One should, though, be careful about the interpretation of these figures, as the causality is not clear. On the one hand one may presume that firms with former DKPTO-staff will increase their patenting as they have the expertise in-house and as they are presumably more aware of the possibilities and necessities in patenting. On the other hand, one may think that firms are inclined to hire DKPTO-staff because they increased their patenting and therefore need, or cost-efficiently benefit from, having in-house expertise.

Other hypotheses may be derived on what is the background for the intensity of knowledge flows. One hypothesis discussed in chapter two, is that knowledge transfer and learning is often interactive and mutual. We may therefore put the hypothesis that an overlap between firms whom think they learned from the DKPTO and firms who think that the DKPTO learned from the interaction. We may therefore expect a higher propensity of firms answering positively to both questions on learning from and to the DKPTO. Indeed this is also the case. However, the differences are not statistically significant due to a low number of observations.

Table 6.11 Learning from DKPTO combined with learning to the DKPTO.

	Very high/High learning effect of DKPTO	*Some/small/no learning effect of DKPTO*	*Number of observations*
Very high/High/some learning effect of firm	20 (48%)	22 (52%)	42
Small/no learning effect of firm	37 (28%)	94 (72%)	131
total	57 (33%)	116 (67%)	173

Note: Learning effect of firm includes ”some” category in order to increase the number of observations.

As mentioned, it was emphasized in chapter 2 that an absorptive capacity is important in order to make knowledge useful and to facilitate knowledge diffusion in the economy. Although it may only be an approximation then the innovation intensity of firms may in some respects indicate an absorptive capacity, at least in the present connection where IPR is in question. Table 6.12 shows the average innovation intensity in two groups of firms with high or some learning effects from DKPTO and firms with low/no learning effects. The innovation intensity is calculated as the number of innovations per employee in the firm in 2001. Z-values show whether the averages are significantly different within a 5% level.

Table 6.12. Innovation intensities in learning/non-learning firms

	Mean	**Median**	**N**	**z-value**
High/some learning effect of DKPTO	1.10	0.10	60	1.19
Small/no learning effect of DKPTO	0.53	0.10	43	

Note: The critical value for a standard normal distribution at the 5-percentage significance level is 1.65. Numbers market with * are significant at a 5 percent level.

Similar calculations have been done on number of patents, number of innovations, size of firm, number of personnel in innovation. However, these analyses did not render statistically significant differences, although both the number of innovations and the number of patents did show some differences in favour of firms who had large learning effects from the DKPTO.

It could be that learning effects are related to the age of the firm. It is however, not totally clear what is the most appropriate hypothesis. On the one hand, one should expect old firms to have greater absorptive capacity and to have needs that are more specific and therefore perhaps more readily identification of the learning effects. On the other hand, it may be that firms over time generate their own expertise and consequently will have less need for the DKPTO services. Table 6.13 indicates that none of these hypotheses is valid.

Table 6.13. Years of establishment in learning/non-learning firms

	Learning			***None learning***			***z-value***
	Mean	Median	N	Mean	Median	N	
Years of age	1964	1975	98	1964	1980	67	-0.02

Note: The critical value for a standard normal distribution at the 5-percentage significance level is 1.65. Numbers market with * are significant at a 5 percent level.

Similarly, one may propose that the DKPTO are more likely to learn from firms the more innovative they are (table 6.14 and 6.15).

Table 6.14. Innovation intensities in firms who transfer knowledge to DKPTO

	Mean	**Median**	**N**	**z-value**
High/some learning effect of firm	1.50	0,09	30	1.64

Small/no learning effect of firm	0.54	0.08	73	

Note: The critical value for a standard normal distribution at the 5-percentage significance level is 1.65. Numbers market with * are significant at a 5 percent level.

Table 6.15. Patents in firms who transfer knowledge to the DKPTO

	Mean	**Median**	**N**	**z-value**
High/some learning effect of firm	52*	19	29	2.26
Small/no learning effect of firm	12*	3	85	

Note: The critical value for a standard normal distribution at the 5-percentage significance level is 1.65. Numbers market with * are significant at a 5 percent level.

The two of our innovation indicators displayed above confirm our hypothesis that firms who provide knowledge to the DKPTO are innovative. However, the number of innovation personnel does not show that pattern.

6.5. The importance of being domestically located

In section 2.7, we put forward arguments from the innovation systems literature as to why the innovation system prevails as a national system. This includes the specific, national endowment of institutions in the innovation system. With respect to national patent offices, it has been explored whether such offices should be upheld or harmonisation should entail not only legislation but also the organisational (centralisation) or patent procedures[63].

One of the important issues in the interviews was the opinion of firms as to how important it is to have a national patent office. Table 6.16 show the overall distribution of answers on that question.

Table 6.16: Perceived importance on use of services of the DKPTO being a domestic patent office, %.

None/negative	*Small*	*Some*	*Large*	*Very large*	*Do not know*	*No. of obs*
38	10	20	20	11	2	195

Again, the assessment of the level of the percentages is difficult since there is no "expected level of importance against which to compare the answers of the firms. If anything, the answers indicate considerable disagreement concerning the importance of the DKPTO being a domestic institution. Half of the respondents attach none or small importance to the national location, but one third sees it as having large or very large importance. The case studies reported in chapter 5, rendered roughly the same picture. Differences across size categories are small. Only in the very large firm segment, there is a significant tendency of attaching less importance to the domestic location of the patent office.

[63] See e.g. Koper (2001) for an account (although one-sided) of the discussion.

The share of respondents who attach any importance (even if only small) to the location, were then asked to specify this importance (if any) on the following possibilities:

- avoid language barriers,
- higher competences in treatment of applications,
- avoid cultural barriers,
- better possibility for dialogue,
- speed of treatment and
- price.

More than one reason was open to the respondents. As mentioned, in this question it was a precondition that the respondent attached importance to the fact that the DKPTO is located nationally, as it would not make sense to ask about specific effects if no importance is attached at all. Consequently, the number of respondents was reduced from 195 to 120.

Table 6.17: Advantages of being nationally located, pct. listing a reason.

Advantages	*%*
better possibility for dialogue	84
avoid language barriers	73
Speedy treatment	63
avoid cultural barriers	56
higher competences in treatment of applications	24
price	21
Other contributions (share who list one or more)	29

The respondents think the main advantages of dealing with a domestic patent office is related to better possibilities of dialogue and direct contact on Danish language. This corresponds with previous discussions in chapter 2 and 5. The competencies do not seem to be an important parameter.

An important aspect in this connection is the potential difference between small and large firms, as one could presume that especially small firms could be inclined to prefer a national office. This presumption is to some extent justified from the findings in the case studies. A previous survey (DKPTO, Oct. 2000) in which 451 firms were surveyed with the specific aim of revealing barriers to patenting amongst SME's did not reveal if geographical proximity matter to small firm patenting. Therefore, the 120 firms are sub-divided into two groups, one with an above median number of employees, another with below the median number of employees. The share of firms within these two groups listing reasons for the advantages of being domestically located are then listed in table 6.18.

Table 6.18: Advantages of being nationally located, pct. listing a reason by two size groups.

Advantages	*Large firms*	*Small firms*
	%	*%*
better possibility for dialogue	83	88
avoid language barriers	72	75
Speedy treatment	60	67
avoid cultural barriers	57	57
higher competences in treatment of applications	19	30
price	26	17

From table 6.18, we may conclude that the tendency of small firms being more in favour of a domestic location of the patent office is only very small and statistically insignificant.

Two other indicators of the issue of location of the patent office should be emphasized. First, it was asked if firms within the past 5 years submitted one or more patent applications directly to the European Patent Office in Münich. The responses to this question were naturally conditioned on two other questions, namely if they had a patent application within the past 5 years and secondly if they were aware that a European Patent Office exists (78% knew this). Out of the remaining 153 respondents after these conditions, 27% answered that they did so. There is a tendency that large, old firms have submitted directly to the EPO.

Secondly, the firms were asked if the patent application were in any respect made easier because a domestic patent office exists. Again, answers are valid only if respondents had one or more patent applications. 70% out of 89 relevant firms (those who applied for at least one patent at the DKPTO) confirmed that indeed it has been easier to apply for patent due to the domestic location of the patent office. No significant differences across firm size appeared.

To further explore these answers we list below the combination of firms with an assessment of respectively large/some and small/no importance attached to the domestic location of the patent office, and of firms who list a factor as important to facilitate using a domestic office. We would expect the results to resemble those of the pure frequencies of table 6.17 as the questions behind table 6.17 and 6.19 are highly correlated.

Table 6.19: Large / Small importance attached to nationally located PTOs combined with reasons for preference towards buying services from domestic PTO. Pct.

Advantages/Easier application	*Large importance*	*Small/no importance*
better possibility for dialogue	91	47
avoid language barriers	79	47
speed	68	40
avoid cultural barriers	60	27
Higher competencies in treatment of applications	25	0
price	26	26

Additionally, one may think that these reasons are correlated with assessment re if domestic location makes patent applications easier in any way.

Table 6.20: Easier application to nationally located PTO combined with reasons for preference towards buying services from domestic PTO. Pct.

Advantages/Easier application	*yes*	*Not easier*
better possibility for dialogue	88	73
avoid language barriers	78	64
Speed	66	55
avoid cultural barriers	60	45
Higher competencies in treatment of applications	22	9
price	28	18

Even if the number of observations is greatly reduced in this calculation (because of combined conditions – must have patent application + answered yes or no in two other questions) the ranking and even the percentages are roughly the same as in table 6.17. The respondents who see the domestic location as easing the patent application and the respondents who attach large importance to the domestic location are more likely to list a reason than "other firms."

6.6. Conclusion

The survey has shown a useful way of getting the broader picture of the role of the DKPTO in innovation. Moreover, it has proven to be a complementary to the case studies in chapter 5.

We have found that firms disagree concerning the question of learning from interacting with the DKPTO. There are 41% of firms who attach large or very large effects when seen in connection with a specific task, and 34% see large learning effects on IPR issues generally. 57% and 62% (respectively) of the respondent perceive, however, learning from interacting with the DKPTO to be relatively modest.

This, in combination with other results from the survey, made us conclude the that effects of the DKPTO on innovation is primarily focused upon increasing general awareness of IPR, as well as on and on providing guidance with respect to applications. Firms did not see the role of the DKPTO as neither improving the capability of the firms to develop new products/processes nor to improve the R&D-activities of the firm.

There were 12% of firms that stated their organisation had hired people previously employed with the DKPTO. In theory, this should be a source of knowledge diffusion. However, we were not able to find this effect in the data. It should, though, be emphasized that more research is needed to reach a firmly rooted conclusion on this.

Of the firms who did learn from the DKPTO, the innovation intensity is higher. Likewise, those who transfer knowledge from the firm to the DKPTO are more innovative and more patent intensive.

A third of the companies see the domestic location of the DKPTO of having large or very large importance. In particular, firms see advantages as more easy dialogue, and the advantage of being able to communicate in Danish. Thus, at least the communicative processes are likely to benefit from the availability of national entries to the patent system. This is partly confirmed by the responses concerning the advantages of nationally located patent authorities (table 6.17). There are only minor indications that small firms are more prone to prefer a domestic location of the patent office.

7. Conclusions – the general effects of DKPTO on knowledge transfer and competence building

This chapter conclude the analyses by summarizing briefly the main results from the research on the role of the DKPTO in the Danish innovation system. In particular, it was contended in chapter 1 that the interaction between firms or individuals applying for patents and the patent office would add to the competencies with both parties. In the end, this may have positive effects on the innovative abilities of the firms and their awareness on and actual use of the IPR-system. Moreover, the competencies in the patent office may increase as a result of this interplay. Internal competencies resulting from processing applications may then spill over to other parts of the organisation thus enhancing these other parts' ability to provide services, not only to firms directly (as was the main focus in this study), but also indirectly through various types of intermediaries.

An important part of the study has been to develop a theoretical framework for our further research. By reviewing relevant literature on knowledge, learning, development of intra-organisational competencies, national innovation systems, and by applying these general theories to our case we discovered important ramifications for the empirical study, as well as other important insights in their own right. More specifically, we pointed to different ways of transmitting different kinds of knowledge like codified and tacit knowledge. We thus pointed to the need to study the nature of knowledge to be exchanged between S&M-department and patent examiners. A successful exchange of knowledge is, however, dependent upon the capacity with the receptor to absorb the knowledge. The absorption of knowledge and development of competencies may be assisted by way of internal organisation.

We proposed in our theoretical development that transfer of tacit knowledge may be stimulated if organisations are conscious about creating room for mutual exchange of knowledge in a personal interaction. We argued that it is indeed a challenge for organisations to transform and diffuse knowledge produced within one unit to other units in a productive manner, but it is often an important part of organisational learning. The implications of these results are that we need to examine further whether mutual exchange of knowledge between departments is deliberately stimulated. If the efficiency of activities of Sales & Marketing is dependent upon diffusion of knowledge from patent examiners (as argued in chapter 1), it requires that mechanisms of knowledge transfer be established with the objective of ensuring knowledge transfer. With limited interaction between departments, this transfer is unlikely to take place. In a dynamic setting, the establishment of such an appropriate level[64] of learning processes may be part of an overall strategy for organisational development. Although close cross-departmental cooperation is likely to add to the competencies and efficiency of both the Sales & Marketing section and the patent section, the point is not that the Sales & marketing section is dependent upon DKPTO patent examiners. Rather the point is that many of the services rendered depend on the competencies of patent examiners. In popular wording, the Sales & Marketing section need to have a firm knowledge of what they are selling and they need to have a good product to sell.

[64] Note that learning is usually considered a positive thing. However, as learning processes may be costly there is a limit to how far it is rational to go in investing in the build-up of organisational structures conducive for learning processes. In fact, it may in some cases be rational to have less close interaction, as was discussed in chapter 2, and as has been referred to in the literature as "the strength of weak ties".

Additionally, we applied the recent theories on national innovation systems to our case. We argued that the importance of the nation persists even in a globalised world. In fact, it may be argued that globalisation and increased importance of local/regional environment goes hand in hand.

We have shown in our institutional mapping, where the DKPTO fits and what are its relationships in the innovation system, including demonstrating that its associations with external organisations are not only confined to industrial firms. A wide array of other relations is important in the overall picture of the position of the DKPTO in the innovation system. This reveals that although the DKPTO has direct contact with many firms, its indirect role as a provider of information and knowledge to other organisations should not be underestimated. Thus, it was discussed in section 3.4 that innovation increasing depends on a still larger and wider number of different framework conditions and that innovation most often takes place in collaboration. This accentuates the importance of the DKPTO, helping other intermediaries to interact efficiently with firms. It also says that the traditional classification of patent offices, as exclusively regulatory institutions, may be too narrow. The research reveals that the DKPTO to some extent has a complementary role as a knowledge-diffusing organisation. We illustrated this by showing DKPTO relationship to patent agents, as this is characterised by both aspects of competition, collaboration and producer-customer relations. The more difficult question is though, how strong is this effect?

The general impact of the DKPTO on knowledge transfer is, according to both the case studies and the survey alike (we generally found similar conclusions in the case studies and the survey), primarily in increasing the awareness of IPR among firms. For example, the increase in the knowledge of firms on the awareness and use of IPR generally, was ranked in top of possible contributions from interacting with the DKPTO. In addition, there is a flow of qualified patent caseworkers from the DKPTO to the patent agents (and to large industrial firms), which in itself means a transfer of knowledge. This issue was observed and later analysed both in the case studies and in our survey. In the survey, 12% of the firms stated they had one or more employees who were previously employed with the DKPTO. The effect of this knowledge transfer was, however, difficult to estimate based on our empirical research. We pointed to the necessity of further research to shed more light on this theme.

With respect to the internal competencies, we found that it is crucial for the production (and supply) of technical business services that the technical expertise is readily available. In the DKPTO these services are supplied without any intensive cross-departmental knowledge flows or close cooperation between patent examiners and the Sales & Marketing section. The knowledge involved is furthermore primarily of a codified nature. The division of labour and procedures was well-defined and the need for increasing knowledge flows was felt greater within departments than between departments. Consequently, there were no efforts to creating environments for learning between the departments. The need for such efforts was not obvious. The accessibility of patent expertise was important, but we did not find arguments for having access to this expertise in-house. The separation of the two functional groups, and the codified nature of the knowledge needed, means that, in principle, it would be possible to buy the examination expertise elsewhere, if it were readily available. In practical terms, there are a number of objections to a separation of functions. It is the responsibility of the government authorities to do application processing. This is due to considerations on equal process, secrecy, and the risk of disqualified processing.

Turning to the knowledge spillover in the innovation system as a whole, rather than intra-organisationally, we found that interaction with the DKPTO does not seem to render much spillover of technological knowledge. We have seen clearly that firms do not attach great importance to the direct help of the DKPTO in Danish firms' innovation activities. This does not rule out that the DKPTO is part of the innovation system in Denmark. The offices role is, however, of an indirect character. As described earlier, the DKPTO is, particularly important in awareness raising concerning IPR. This was evident in our analyses in chapter 5 and 6.

One may question if these functions could effectively be taken care of by EPO, patent agents, or some other institution. This issue of centralising or decentralising the patent system was in fact part of our questions to respondents in both case studies and survey. Drawing upon chapter 2 and the results from the survey, and partly the case studies, our answer is somewhat ambiguous. Certainly many firms, especially the large firms, would not mind if the functions mentioned in section 3.3 were fulfilled by the EPO. On the other hand, we saw in the survey and in the case studies, that in particular, small, new firms may feel more confident with a national patent office in the proximity, with its familiar and national language. This was discussed in chapter 2, where knowledge flows were seen as depending on common codes of understanding and cultural, and geographical proximity. These reasons for preferring a national location of the patent office were confirmed in our survey by the firms who preferred a domestic location, and partly in our case stories. It should be noted that the firms of the case studies did not ascribe the domestic location of the patent office much importance to their patent activity. Our survey revealed that about half (48%) of the respondents attached small or no importance to having a national office while, on the other hand, about one third (31%) saw it as being of large or very large importance. However, both the results of the case studies and of the survey suggest that the availability of a national patent office does not affect the innovation level of most companies (cf. section 6). Even if some companies find it convenient that there is a possibility of filing applications via a national patent office, the application process (and the possible diffusion of knowledge through this process) does not in itself affect the level of innovation.

In conclusion, the results of this analysis concerning the general role of the DKPTO in the Danish national innovation system remain somewhat ambiguous. The role of the DKPTO seems to be to contribute to general IPR awareness and to bring together the IPR branch by constituting central focus point for common interests. There are some indications that the DKPTO serves a role in facilitating easy access to the patent system for SMEs by lowering the (cultural and linguistic) barriers of IPR protection. Moreover, there are indications that the DKPTO serves a function as training patent engineers who after a period in the DKPTO are employed in other organisations. The empirical evidence is, however, not entirely unambigous on this point and further research is therefore called for. In particular, the role of the DKPTO in terms of stimulating innovation directly seems to be very modest[65].

From a general European perspective, the question of the future role of NPOs is highly relevant in this connection. The empirical evidence of this analysis does not allow a general conclusion concerning the possible obsolescence or indispensability of these institutions as this may differ from country to country[66]. The role of individual NPOs should therefore be carefully considered.

[65] This is after all is no big surprise considering the results of innovation research in general and the ranking of information sources for innovation displayed in table 3.1.

[66] Of course this would not affect all members of the EPO equally. The role of national patent offices in national innovation systems differs from one country to another. These differences could be subject to further

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research through comparative analyses, which might give an overview of the effect of centralisation at a cross-European level. In particular, it would be interesting to study whether it actually has been the case that patent expertise are indispensable and if they have in fact vanished in those countries who gave up to have a national examination procedure.

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